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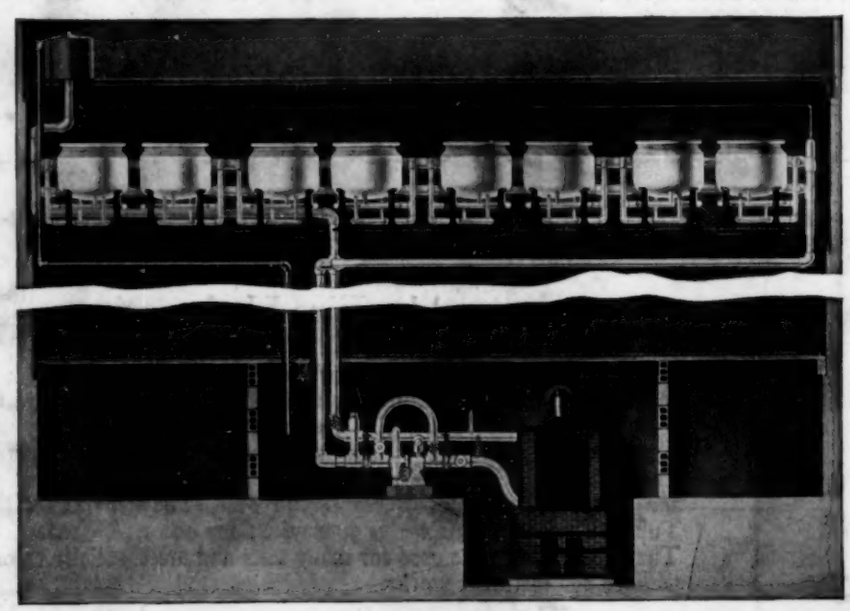

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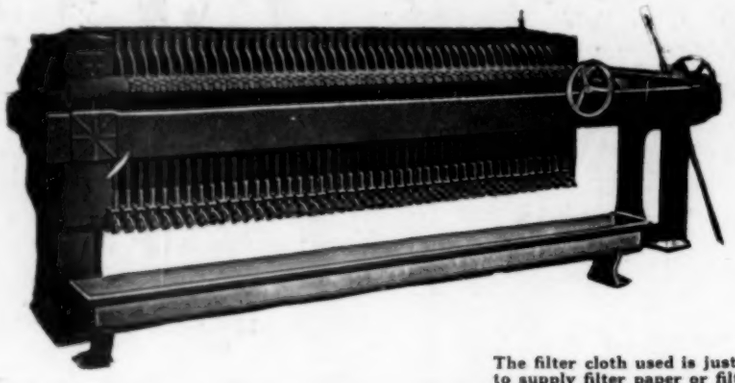

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CHEMICAL & METALLURGICAL ENGINEERING

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H. C. PARMELEE, Editor

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Problems in the Production of Sodium Sulphide

DURING the years 1917 to 1920 there was an annual production of sodium sulphide in this country of 45,000 tons. The size of this industry has been the cause of considerable surprise, for it is not generally recognized that sodium sulphide is so important a commodity. It is obtained both by the reduction of salt cake, sodium sulphate, with coal, and as a byproduct of the barium industry. Since the ultimate survival of the barium industry in this country is at least partly dependent upon the tariff, it cannot be regarded as a basic source of sodium sulphide. Future progress in production, therefore, is rather definitely limited to improvements of the technology of the salt cake process.

The furnacing of salt cake to produce sodium sulphide is a good example of a common type of problem met in chemical industry. The technology is surprisingly primitive and improvements are easy to visualize. But when it comes to the point of changing the process, it is impossible to show *a priori* a distinct advantage for the improvement, even on paper, because of the many variables. Moreover, the industry is bound by conservatism to an extraordinary extent.

At present salt cake is mixed with about half its weight of coal and treated in a rotary or reverberatory furnace. The material is gradually heated until it melts and reduction begins. As the reduction nears completion the mass becomes more and more solid until finally the charge is dumped and the cycle is repeated.

Perhaps the first thought that occurs to the average chemical engineer who observes this process is to make it continuous. But a continuous process must take care of all three stages—preheating, fusion and reduction. The character of the charge changes fundamentally during the reaction from a mixture of finely divided solids to a mobile liquid and partly back to solid again. To attempt to carry out such a reaction in a rotary furnace would require a much longer one than is at present used, the operation being perhaps analogous to that of cement burning. But the changes of state which the charge undergoes would present grave if not insurmountable operating difficulties and these would be enhanced by the fact that sodium sulphide burns rapidly after the reduction is complete.

Thus the time factor is seen to be of vital importance. This is the reason why the continuous process used for the reduction of sulphate in the paper industry cannot be applied to the manufacture of sodium sulphide, for in the paper industry reduction is not complete and the presence of sodium carbonate, the product of sodium sulphide decomposition, does not represent a serious loss.

Other methods, which get away entirely from the rotary furnace process, have been suggested. One of the most promising consists in injecting a finely divided mixture of coal and salt cake at the top of a stack. The tower would be heated by means of tuyeres and the mixture would work to the bottom where the products would be removed. The improvements in yield and replacement cost which would result from this or any other radical change can be estimated only after complete investigation. Meanwhile the cost of the investigation, the high investment in present equipment and the lack of any positive assurance of satisfactory results have held back investigation and consequently defeated progress.

Long-Term Credits And the Fertilizer Industry

PROMINENT men in the fertilizer industry have stated frequently during the past 2 years that the sale of fertilizer on long-term credit is one of the very serious problems. Stated briefly, the situation is this: Fertilizer is delivered before the crop is planted and paid for after the crop is sold. If, as in 1921, there were large financial losses and many failures on the part of the farmers, the bills would not be paid until the harvesting of the next year's crop. Naturally this would have to affect the price of fertilizer during the following year, as at least the interest on the money involved would have to be absorbed.

Several statesmanlike addresses have been made on the subject to fertilizer manufacturers in which the imperative need for doing cash business was urged. It is a real handicap for the industry to have to act as banker for its consumers and it militates against the proper development of local banking. Of course historically the industry has only itself to blame. For the practice was started in order to increase sales and to establish the confidence of the consumer in the product. Now the producer can't let go. During this last year an increase of cash business has been reported, but we learn from those associated with the industry that it is very doubtful if it will ever be able to emancipate itself from the granting of long-term credits.

To the outsider it looks as though severe competition actually has proved undesirable for the consumer, which is a peculiar anomaly. So anxious is the individual manufacturer for business that if one producer were to offer cash terms only, the customer could shop for material elsewhere and get it on the old terms, which almost amounts to "pay when you get ready." So the net result is that because of intense competition the industry must still adhere to the antiquated procedure and carry the customer till after harvest. This must cost the customer more than straight interest which he would pay as discount on a commercial loan at a local bank, for there is much more risk for the manufacturer than there would be for the local banker, who is in

closer touch with conditions. Here is a case where a gentleman's agreement ought to be of distinct benefit to the consumer, to say nothing of the producing industry.

Our Problem Of Immigration

SINCE 1882, when Congress passed the first general immigration law, this country has been experimenting with various measures designed in one way or another to curb or limit the incoming stream of foreigners. In all that time, however, we have never formulated what might be regarded as a permanent immigration policy. To find the reason for this it is necessary to go back a bit into history.

In the past 40 years our attitude toward immigration has completely changed. For several decades before the war the subject was regarded purely as an economic problem and the immigrant's effect on American industry and American wages was the paramount consideration. Little thought was given to the social aspects of immigration; the capacity of our great melting pot was believed to be unlimited. But the developments of the war very abruptly changed our viewpoint. The racial characteristics and the quality and character of the incomers were more carefully studied. Their attitude toward American institutions and toward our standards of living completely overshadowed any economic questions involved. Already it had become apparent that there was danger of too much infusible material in our melting pot and that slag inclusions were threatening to weaken the pure metal of American citizenship.

This change in attitude was to some extent attributable to a very important change that has occurred in the character of immigration. From 1870 to 1890 practically 90 per cent of our immigrants were of the Nordic races, coming from northwestern Europe—including the British Isles, Germany, Scandinavia, Belgium, the Netherlands and France. But about 1900 a different trend became evident and the Slavic races appeared on our shores in ever-increasing numbers. Soon Italy, Austria-Hungary, Greece and the other countries of southern and eastern Europe were supplying as much as 80 to 85 per cent of all our immigrants. And these newer arrivals were less stable, inclined to be radical and somewhat more than a third of them were illiterate. Furthermore, they were not readily assimilated.

While the Nordic immigrants had gone largely to the farms and factories, the Slavic were generally unskilled laborers and were satisfied to remain so. Still another complication in recent years has been the increase in the proportion of Jews of a type inclined to enter trade rather than industry or agriculture.

The present 3 per cent immigration law, admittedly an emergency measure, has not contributed a great deal to the situation. Designed to limit admission from any particular country to 3 per cent of the number of that country's nationals shown in our 1910 census, the law made the fatal mistake of failing to take into account the number who returned to their former countries. This accounts for such inconsistencies as the admission of only 42,000 Italians last year during a period when 53,000 former immigrants actually returned to Italy. The principal good that has come from the present law, however, has been the material reduction in the proportion of undesirables. Southern and eastern Europe, instead of supplying 750,000, as in many past years, was limited under the quota law to 155,000. Needless to say, the quotas from these countries are always filled. Thus the maximum number of Greeks and Turks to be admitted during the year ending June 30, 1923, had already been supplied as early as November, 1922.

As the present business revival continues there is a clamor in many industries for more workers—in fact, it cannot be doubted that in many localities there is an actual dearth of unskilled labor. Pressure is being brought to liberalize the immigration laws, to let down the bars in order to satisfy the economic needs of the country. As a nation it would seem that we are confronted with the problem of polluting our blood stream in order to get economic relief or of preserving our blood stream pure and suffering an economic loss.

What, then, is the way out? In formulating a permanent economic policy toward immigration (and we can never get anywhere until we do) we are confronted with the necessity of effecting a working compromise between these views. But, at the same time, a number of other factors must be considered. Qualitative selection of the immigrants to be brought in and their intelligent distribution after they arrive would certainly seem advantageous. After excluding the undesirables, the aliens in the country might be registered and their movements followed closely for the first year or so in order to observe their progress in Americanization and their industrial occupation and service. Finally, it might be possible for an immigration commission to keep informed about available supplies of foreign labor, in order that we might know where to turn for the sort of man power needed by our industries.

While the framing of an immigration policy is still in a formulative stage, those of us in industry can contribute to the situation by making the closest study of our own labor problems in their particular relation to the foreign-born worker. It will be only when we can furnish our legislators with definite quantitative information regarding labor shortage, turnover and efficiency and interpret this in terms of nationality, race and length of service that we can expect to have a scientific solution of our immigration problem.

The Menace of Loosely Drawn Contracts

PROBABLY a vague security is felt by a manufacturing organization in contracting for all of its "requirements" in a given commodity, for the practice is widely followed. In many cases it is harmless, as when a relatively large producer agrees to take care of a relatively small consumer. In such a case the maximum requirements of the consumer will hardly be an appreciable percentage of the producer's output. But where producer and consumer are more nearly the same size and where variations in consumption may be a relatively large percentage of the total output, the contract must be drawn with considerable care. Loosely drawn contracts are especially a menace in such a case and the court records are filled with disputes about them. Exactly the same thing is true of the converse, where the total output of a factory is contracted for. The many cases cited by WELLINGTON GUSTIN elsewhere in this issue strikingly confirm this fact.

The reasons back of the practice of making loosely drawn contracts are probably more fundamental than mere carelessness or ignorance. There is a tendency to believe that in vagueness of expression lies a flexibility from which advantages may accrue. It is usually forgotten that flexibility is a two-edged sword and that the advantage may lie with the other party. In addition there is also the contract which does not express ac-

curately the purposes of both parties. This is caused by loose thinking which makes for inaccurate wording. Such a contract may be made with perfect good faith on both sides.

Nothing more completely destroys the friendly good will which is the leaven of business relations than a dispute about money—a dispute in which both sides feel that they are being wronged. Mr. GUSTIN'S article is of great value because it focuses attention on a fundamental principle which must be periodically called to mind. Good faith alone is not adequate in business dealings, but must be supported by accurate expression and complete understanding in and through business contracts. Good contracts are promoters of business health.

Dirt
In Steel

PRIOR to the war most all steelmakers thought that slag and metal had some mutual repulsion, like oil and water. They would not mix, and if you gave the metal a chance to settle quietly in the furnace, ladle or even in the ingot mold, all the slag would gather on top, separated clearly from metal free of the last traces of slag. Then if the ladle and mold were clean of dirt, the resulting steel would be sound, except perhaps for a few surface seams or blisters which perhaps were healed in rolling, some blowholes which could always be welded shut, and maybe some pipe or shrinkage cavity in the top, which could be cropped.

Some steelmakers, and big ones at that, think so yet. They are sure that those little black spots which must be hunted for with a microscope cannot have any influence on the quality of steel; things so little don't count. Anyway, the chemical analysis is all right—sulphur and phosphorus are both low. Gas? "Why, how can there be any gas in that solid, dense metal? Besides a cubic foot of gas is almost too light to weigh, and that much steel weighs 500 pounds; if there ever was any in the blowholes it is all squeezed out. You scientific men are always looking for troubles which do not exist—here's good, sound dependable metal we can make in large tonnage. Why are you so fussy about it? Perhaps there's a bad piece in it now and then, but we'll gladly replace those, and it's good uniform stuff. We stake our reputation on it. Would you think that Professor Micrograph knows more about steel making than our experts and the combined lifelong experience of the Tonnage Steel Co.? If a ½-in. section gives you a few failures, use a ¾-in. section."

But there are some problems which can't be solved that way. During the war, recoil cylinders and gun tubes had to be made in great numbers, strong against great bursting pressures and yet light enough to be manageable in field pieces. And for the life of them, the Tonnage Steel Co. and all its experts could not pass the inspection more than ten times in a hundred. Alloy steels were blamed. If only carbon steel were specified, of course that would have been a different matter!

The war is over, but like the peace such metallurgical troubles are still with us. We are more and more interested in high-speed transportation. Forgetting airplanes and subways (although the matter applies to them as well), automobiles are driven at 50 miles per hour oftener than they were sent 35, five short years ago. Every increase in speed increases the required power much faster, throws stresses into each member at a greater rate and searches out hidden defects in all parts ceaselessly. So the world moves, and because a certain brake drum made from Tonnage Steel Co.'s carbon steel has been turned out by the million, there is no reason to suppose that that design is the best there is, that it will be used forever, or that disastrous failures will never occur with faster and faster driving.

In fact, such a condition actually exists. We have in mind a manufacturer of a very fine automobile which has built up an enviable record for quality and reliability. Each part going into the machine is carefully made, under constant and minute inspection; stock parts are tested by lots before assembly and each finished car is taken out on a test run by a driver determined to jar loose anything that is loose. Production had practically been standardized, yet without any very great difference observable in the routine tests, the number of failures during test runs gradually increased in both carbon and alloy steel parts to an alarming proportion. What was worse, reports of one or two failures in service began trickling back.

After intensive investigation the cause of these failures was found to be almost invariably the same as the cause of our old enemy "flakes" in alloy steel: dirt. Close visual inspection of finished parts or fresh fractures would not reveal any sign of trouble. Nor would there be anything wrong in the chemical analysis. Microscopic examination of etched samples seemed also to give acceptable structures—not particularly free from ferrite banding and ghosts, and yet not noticeably worse than acceptable material. However, a polished unetched section invariably shows a great number of round black spots apparently hidden by etching, many $\frac{1}{16}$ in. across or larger and not more than ¼ in. apart at 100 magnifications. Often these are arranged in rows, whereupon a service-fracture would follow a series of these rows and exhibit an appearance of stairsteps. If a broken connecting rod was pickled deeply, all manner of seams appeared, apparently the vestiges of laps, pipes and unwelded blowholes.

Of course, the Tonnage Steel Co. would not accept the blame, nor be held to a specification demanding less dirt. It wouldn't admit that any dirt was there! But less conservative concerns were willing to make smaller heats of steel, exerting the most extreme care and the utmost resources of modern electrometallurgy. The result, while not perfectly clean steel, is certainly far ahead of anything to be had on the open market. And the proof of the matter is this: that when a troublesome part is made of clean steel, alloy or carbon, failures suddenly cease!

So, at the present time, most of the energies of the metallurgists of that motor company are devoted to an endeavor to get cleaner steel for forgings and bar stock. Their specifications now read, in effect, "The steel shall be free of blowholes, internal defects and solid non-metallic inclusions—the purchaser to be the judge of this requirement." Microscopic sections are taken of all highly stressed parts regularly and examined for dirt. It has even been found necessary in a number of cases to specify steel made by certain processes as being superior to ordinary material in the matter of cleanliness and cleanliness only. It has been found that certain makers furnish far cleaner steel than others, apparently as well equipped. They get the business.

Viewing this compelling fact, we take hope that eventually the Tonnage Steel Co. will become convinced that dirty steel is not a mere scientific speculation.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, Dec. 20, 1922.

CHEMICAL markets continue in quite a cheerful and healthy state and there is nothing abnormal about the usual falling off of business because of the Christmas holidays and stock taking. There is no doubt that the demand for general and heavy chemicals is likely to be greater in the New Year not only on account of the general improvement in the industrial outlook but also because of the government's roadmaking and shipbuilding programs and the schemes for the relief of unemployment. The threatened wage dispute in the chemical trade has also been avoided for the time being, and all these factors, together with the continued fall in contract prices for heavy chemicals, justify a considerable amount of optimism.

BRIQUETTING PLANTS CLOSE DOWN

The position in regard to pitch is at the present time one of peculiar interest. A few months ago the price was $5.50 per ton and since then it has been rising steadily until a level of about $12.50 per ton was reached. The reasons for this enormous increase are not only the closing down of a number of coke-oven plants but an increase in the demand for pitch for roadmaking purposes and the probability of a still further demand as progress is made with the government's program of additional roads and maintenance throughout the country, part of which is in relief of unemployment. Bitumen, of course, has been increasingly used owing to the pitch shortage, but a certain amount of pitch seems to be indispensable in the mixtures usually adopted for making coal briquets. The result has been rather curious, inasmuch as the manufacturers of briquets and patent fuel for anthracite slow-combustion stoves and the like have been unable to pay the high prices demanded for pitch and a number of briquetting plants have had to close down. This has already steadied the advance in prices, but the situation is very uncertain.

PROGRESS IN CHINA CLAY INDUSTRY

The past year has witnessed a remarkable recovery in the china clay industry, the quantity marketed representing more than 75 per cent of the pre-war production and the export trade having been more than double that of 1921. Cornish methods of handling china clay and refining it for the market have always appeared crude and inefficient to the uninitiated. Furthermore, some of the improved machinery installed just before the war was requisitioned by the government. The improvement in consumption has revived interest in improved methods, but it is unlikely that economies are really practicable except as regards fuel and improved grading of the finished product. The new plant of the Standardized China Clay Co. is about to begin operations and comprises four 36-in. Gee centrifugal separators, in which the china clay is automatically divided into four or more grades both as to fineness and quality, the coarser product containing a higher percentage of silica and other impurities. At the same time moisture is brought down to as low as 25 per cent in the machines and an improved gas-heated drier leads to further economies. The high-grade material from these machines commands a considerably enhanced price and it merely required standardization and educational propaganda to enable an increased over-all profit to be obtained. There is also the possibility of further purifying and regrading the inferior product from these machines.

The further study of china clay for its use in chemical manufacture as distinct from those in paper making, pottery, cotton goods and so forth seems well worth while, as there is ample scope for widening the china clay market.

SULPHUR DIOXIDE IN COAL MINING

Coal mining is one of the few industries in which the chemist has not yet penetrated, but a recent investigation by Dr. Lessing has opened up the possibility of using purely chemical means instead of explosives or mechanical cutters, which have hitherto been regarded as irreplaceable. In 1882 the hydration of quicklime was suggested, the expansion acting as a mild explosive in shattering coal. The present suggestion, which is now being tried out on a practical scale at the Brereton Colliery, is that of passing moist sulphur dioxide gas through acid-proof tubes into the bore holes and allowing it to permeate through the coal for some hours. The gas is avidly absorbed by the coal and the calcium and other carbonates, which constitute the bulk of the interfacial layers or partings which cement the coal together, are decomposed, whereupon the coal can be very rapidly broken up and removed. It is stated that 1 ton of sulphur dioxide should suffice for 1,000 tons of coal, corresponding to about 5 cents per ton, and that there is no trace of leakage of gas into the atmosphere of the mine, although in any case the quantity of the gas used would be insufficient to produce injurious effects. Treatment in this way also seems to raise the ignition temperature of the coal after treatment and may therefore constitute a safety factor in coal mines apart from the possibility of replacing explosives by chemical methods of disintegration. The details of routine operations on a large scale should not be difficult to elaborate, but considerable interest has been attracted to the process and to the experiments which are now in progress, especially in mining districts where sulphur dioxide gas is or may be a waste product.

OTHER INDUSTRIAL DEVELOPMENTS

Other recent industrial developments include the use of carbon dioxide from the waste combustion gases of greenhouse boilers, for the purpose of increasing the yield of tomatoes, cucumbers and other hot-house products by approximately doubling the carbon dioxide content of the air in the houses. The possibility of applying this principle to crops in the neighborhood of blast-furnace plants is foreshadowed and two installations are in course of erection. A new process for utilizing blood and tankage for molded articles, insulating purposes and impregnation is being tried out and will be referred to in a subsequent contribution.

The Federal Council for Pure and Applied Chemistry has now published an appeal for funds to enable it to develop its work on an adequate scale. It is pointed out that while today's financial conditions prevent the realization of the large scheme outlined by the late Lord Moulton, it is now essential to make a beginning in the direction of the compilation of chemical compendia and for the cultivation of the social side of chemistry. In this connection the Council has given its official blessing and its co-operation to the excellent work of the Chemical Industry Club, which has just held its very successful fourth annual dinner, at which T. R. Duggan, of the Chemists' Club, New York, was an honored guest.

Microscopy of Paint And Rubber Pigments*

A New Conception of the Place of Microscopy in the Examination of Pigments Involving a Distinct Technique — Uncanny Insight Into Manufacturing Processes Is Made Possible by Development of Science

By Henry Green
Research Laboratory, New Jersey Zinc Co.

LIKE ANY SCIENCE, microscopy is composed of distinct divisions, from each of which a separate art is derived; so we find useful application made of the microscope by the bacteriologist, the petrologist, the metallographer, etc. There is one division, however, which, in comparison with the others, is still very much of an infant; in fact it has not even been christened. For convenience it will be called "pigment microscopy." Undoubtedly there exists sufficient literature on this subject to establish it as a distinct and useful branch of microscopy in itself, but the tendency has been, apparently, to treat it, not as a branch of microscopy at all, but rather as a problem incidental to more important ones in the domain of paint and rubber research.

The plan in presenting this paper has been to reverse the customary procedure and study the subject of pigments mainly from the microscopist's viewpoint, and incidentally point out its utilitarian aspects for the benefit of paint and rubber investigators.

As there is nothing in particular about a *mass* of pigment sufficiently characteristic to be of interest to the microscopist, his endeavor will naturally tend toward an attempt at resolving this mass into its ultimate units or *individual particles*. It is natural to expect that here might be found something that would not only differentiate various pigments but, in addition, throw some light on their behavior when subsequently used in paint or rubber.

The simple procedure of studying the individual pigment particle under the microscope seems like such an obvious thing to do that one would expect that nearly everything in this line had been accomplished some time ago. As a matter of fact, the number of technologists interested in the use of pigments having a clear conception of the appearance and particle size of such materials is almost negligible. About 5 or 6 years ago it was practically impossible to find a paint manufacturer even willing to admit that pigment particles could be seen in this manner. Perhaps a quotation from Bottler and Sabin[1] will help to visualize the situation as it stood then. Sabin states in reference to a microscopic examination of the major portion of elutriated basic carbonate of white lead (one of the coarser pigments):

> . . . and as to the residue comprising portion 5, which makes up the greater part of the pigment, it is not merely hopeless, it is as absolutely impossible (to measure) as it is to "average" the apparent size of the stars in the sky, where each increasing telescopic power reveals new infinites of star-dust.

And again,

> A microscope is an interesting and useful instrument; but the person who uses it is sometimes neither interesting nor useful, and microphotographs may be made and interpreted in all sorts of ways.

All of which indicates that the technologist believed then (and even now, in most cases) that pigments were too fine grained to be seen under the microscope.

Distinctive Technique

When it is taken into consideration that microscopists have for years devoted a considerable part of their time to the study of the minute structure of test diatoms, to the resolution of Nobert lines and to test plates, etc., it is not so obvious why technologists, though admittedly not trained microscopists, should have been unable to cope with a subject as "easy" as the coarser pigments. The answer lies in the fact that pigment microscopy is in itself a distinct division of the parent science. If we do not expect the metallographer, for instance, to excel, without previous preparation, in the use of the petrographic microscope, or the petrologist to feel at home in the bacteriologist's laboratory, then it is unfair to criticise adversely the investigator possessing but a temporary interest in the subject for not having acquired a correct technique for the successful microscopic analysis of pigments.

Recently there have been appearing indications of a keener interest in the subject of pigment microscopy than heretofore. This has been particularly true in the rubber industries. With this in mind and hoping to stimulate further research in this field, the necessary apparatus, methods of mounting, photographing, etc., for such work will be described. It is not to be inferred that this information is exclusively for the rubber investigators, for with few exceptions it will be of a general nature intended for use by anyone interested in pigments.

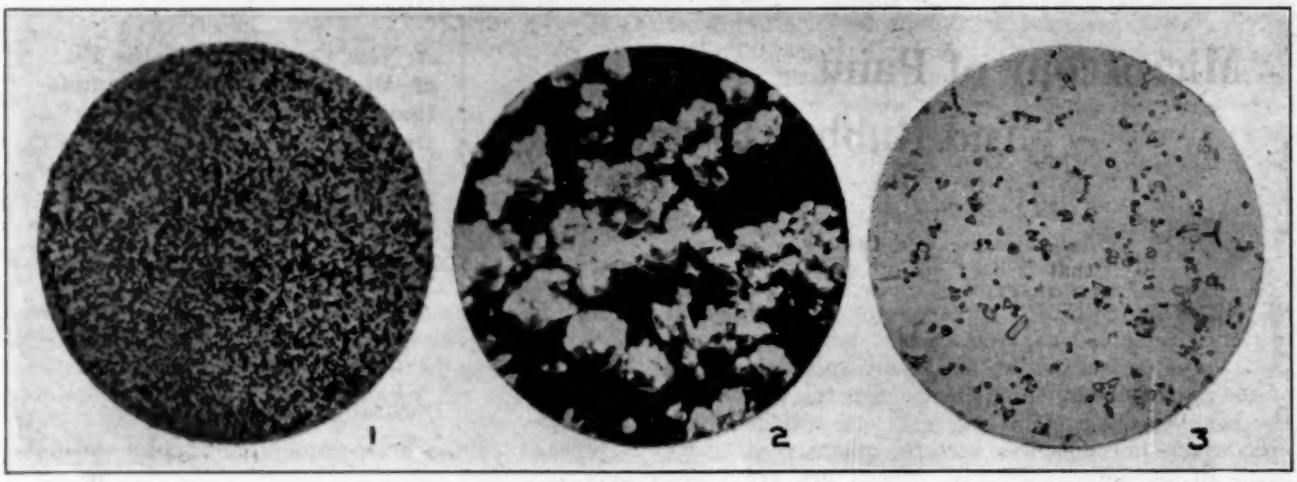
Apparatus Used in Pigment Study

The investigator working in the laboratory of a company either using or manufacturing pigments can gain for himself considerable knowledge of the nature of these materials by simple visual observation with the microscope. However, if this information is to be passed on to various department heads, etc., who seldom, if ever, visit the laboratory, the easiest procedure is to resort to photography; by this means a permanent record of what has been seen is obtained that is often easier to understand than any verbal or written description. Bearing this in mind, the beginner should acquire his apparatus and develop his laboratory accordingly, for eventually, when fully equipped, photomicroscopy will constitute the chief part of his work.

It is convenient, though not absolutely necessary, to have two microscopes. One is to be used for visual work for examining mounts, to note if they are properly dispersed. The second instrument is permanently fixed to a photographic stand and is to be used only for taking photomicrographs. The best stand is the upright type in which the camera can be swung aside to enable the operator to look into the microscope and

*Presented before the Technical Photographic and Microscopical Society, New York, Sept. 14, 1922.

[1] "German and American Varnish Making," by Bottler and Sabin.



FIGS. 1, 2 AND 3

Fig. 1—This photomicrograph is an attempt to duplicate the kind often appearing in print and illustrates the following faults: 1—Magnification and resolving power both too low. 2—Illumination off center. 3—Illumination not critical. 4—Out of focus. 5—Overexposed.. 6—Overdeveloped. 7—Pigment not dispersed.

Fig. 2—A fine grain pigment as taken from its package. Each pellet contains many thousands of pigment particles. Magnification 25 diameters.

Fig. 3—American process zinc oxide taken at 1,500 diameters, showing the characteristic crystalline outlines.

adjust the illumination, which, of course, must be maintained critical and centered. Each microscope should contain its own set of lenses, comprising a 16, 4 and 2 objective and a medium- and high-power eyepiece. A well-corrected oil immersion condenser is required for high-power work. Any of the standard illuminants may be used. The author prefers the blue band of the magnesium spark spectrum to any one of the others. This source of illumination is convenient, easily centered, does away with the necessity of filter screens, and the light is monochromatic and sufficiently intense to take photomicrographs at 1,500 diameters with 30-second exposures. Medium speed plates should be used giving neither great nor slight contrast.

The remainder of the apparatus will include the usual paraphernalia found in any microscopist's laboratory, such as turntables, slides, cover glasses, brunswick black, reagents, etc. A thickness gage should always be on hand in order to obtain correct cover glass thickness for the 4 mm. objective and proper thickness for the slides. The rubber investigator will require in addition a microtome capable of adjustment to 0.5 μ.

Mounting

It has been stated that "photomicrographs can be made and interpreted in all sorts of ways." This is quite true, but the pigment microscopist need not feel any apprehension concerning such a fact. It is very easy to decide whether a pigment photomicrograph is correctly made or not, and if not there is no reason why anyone should attempt to interpret it at the risk of arriving at a faulty conclusion. A properly made pigment photomicrograph can tell only a true story.

If we select almost any series of the published paint pigment photomicrographs and examine them critically, a number of instructive facts become apparent. The first is that there is nothing characteristic about any one of them serving to distinguish one pigment from another. Secondly, if we had no previous knowledge of the subject, it would be impossible to decide if the photomicrograph showed individual particles or not. Our natural conclusion would be that pigment photomicrographs are an excellent example of misdirected energy. In order to avoid such a conclusion, let us ascertain what faults exist that make work of this kind valueless and then determine the best means for correcting them.

Referring to Fig. 1, it is obvious that:

1. The illumination is neither critical nor properly centered.

2. Magnification and resolving power are both inadequate, being much too low.

3. The mount is not properly made. No attempt at dispersion.

With regard to No. 1, this fault exists so universally that it is the rule rather than the exception. Any textbook on the subject gives full explanation of how to avoid it.

The second fault can be attributed to the facts that, first, the cost of high-class objectives is often prohibitive for the small technical laboratory, and second, the untrained microscopist finds such lenses difficult to use. For the most satisfactory work with fine pigments a 2 mm. oil immersion objective is essential.

It is undoubtedly in the third fault where the beginner meets with the greatest trouble. It never occurs to him that the construction of the microscope is such that it is best adapted for the examination of *minute* objects, and, to within reasonable limits, the smaller the objects and the more completely dispersed they are the better suited they become for microscopical examination. As the result of this lack of information attempts are made to look at a great mass of material in which no effort has been taken to spread it out into sufficiently thin sections.

Various States of Subdivision

If we examine any pigment as it is taken from the package, it will be noticed, especially with the aid of a hand lens, that it is composed of small pellets which are soft and quite easily rubbed out between the fingers. (Fig. 2.) The size of these pellets is not necessarily dependent upon the nature of the material, and is in no way likely to influence the quality of the paint or rubber in which the pigment is ultimately used. In fact, these pellets are of no particular interest to the microscopist, but it has been necessary to mention them, for there are instances where technologists have taken such for individual particles. As a rule they are composed of many thousands of particles.

When these pellets are rubbed out on a glass slide in a liquid medium such as water, permitted to stand a few seconds and then examined under the microscope, it will be noticed that the particles have collected into

groups or flocculates. It is on account of this flocculating tendency that it is sometimes so difficult to obtain well-dispersed mounts of pigments.

So far we have recognized three states in which pigment particles will be found to exist—namely, dispersed, individual particles clearly shown; flocculated, individual particles seen only with difficulty; soft pellets, individual particles not discernible.

There is still another condition that has not been mentioned, and that is one which sometimes occurs in precipitates like lithopone. In materials of this type there can often be found small undispersable aggregates composed of a half dozen or more particles firmly cemented together. These aggregates differ materially from the pellets, being very much smaller, visible only at high magnification and function as individual particles.

It is necessary for the beginner to become acquainted with the dispersed state and the three states of aggregation so that he can recognize each one without effort or doubt as to what type it is. The next step is to learn how to make a properly dispersed mount suitable for photomicroscopy.

There are four essential qualities found in a properly made mount.

(1) Proper particle density.

(2) Correct proportion of the largest and smallest particles.

(3) Suitable dispersion.

(4) All particles in a single plane.

In other words, there should not be too many nor too few particles in the field of the microscope; the largest particles as well as the smallest should be present and not pushed off to one side; pellets should be completely rubbed out and flocculation prevented; and all particles should lie in the exact plane of the microscope slide. The instructions for accomplishing these results were first given by the author in the *Journal of the Franklin Institute*, November, 1921. A pigment mount, made in the manner there described, can be used not only for visual observation but, on account of the fact that the particles are cemented in a single plane and free from brownian motion, can be satisfactorily photographed at high magnification. This should be carried out with transmitted light.

Nothing is gained, and in fact a great deal lost, by attempting to employ dark ground illumination, or the ultra-microscope. In this latter case it is impossible to distinguish small aggregates from individual particles.

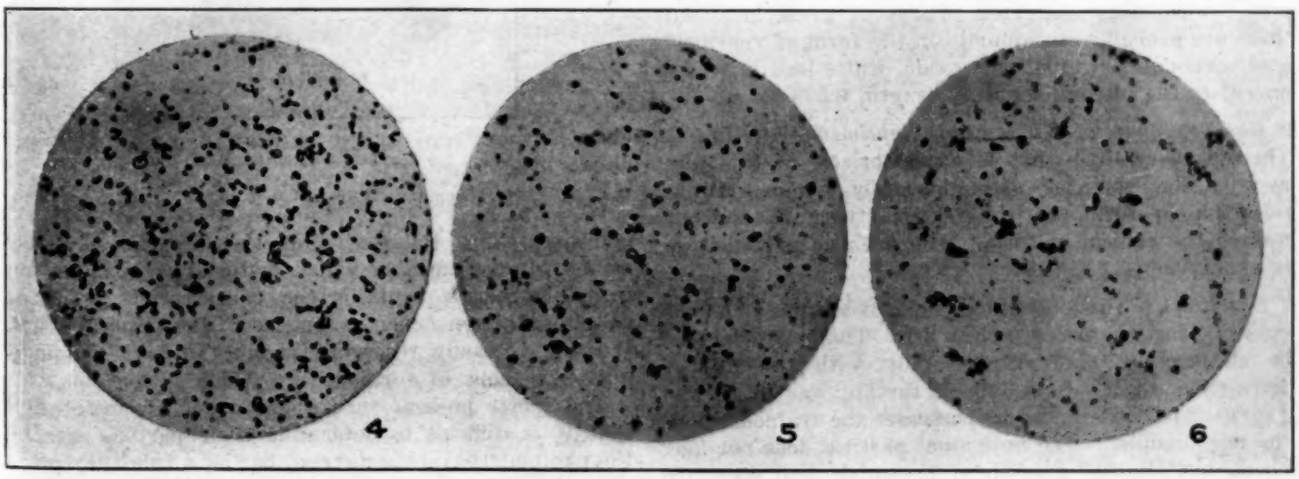
Photomicrographs of zinc oxide, lithopone, iron oxide, gas black, lamp black, sublimed white lead and corroded white lead should be made at 1,500 diameters, preferably with a 2 mm. apochromatic objective and a medium power compensating ocular. When moderate speed plates are used with a 5 ampere arc and a Wratten C filter about 1 or 2 seconds exposure is necessary, if the illumination is properly adjusted. With the blue band in the magnesium spark spectrum (as supplied with the Zeiss ultra-violet microscope) about 30 seconds is required for correct exposure.

The first requisite of a good pigment photomicrograph is that it shall unmistakably show the outlines of the ultimate particle. Preferably the particles should be separated and not touching or overlapping. When this is accomplished, all of the common pigments can be recognized and distinguished from one another without difficulty.

Characteristics of Common Pigments

Zinc Oxide. When this material is made by the so-called American process (Fig. 3), it yields its most characteristic forms. The single crystal particle is a hemimorphic hexagonal prism with acicular tendency. It readily forms twins, threelings and fourlings, all typically characteristic of this pigment. The particle size averages from 0.4 μ to 0.6 μ according to the method of manufacture. When made by the French process (Fig. 4), the particles are much less acicular and there seems to be no tendency for twinning; also the particle size is smaller, usually running from 0.3 μ to 0.4 μ on an average.

The addition of lead sulphate during the process of manufacture produces a solid solution with the zinc oxide causing the crystals to become short and thick. Fumed zinc oxide is always crystalline, though it is often erroneously referred to as amorphous. Microscopic examination of zinc oxide will show whether the material is a "straight" zinc oxide or a leaded one, and in the latter case will often indicate approximately how much lead is present. Furthermore, it can tell by what process the oxide was made and sometimes the type of furnace employed.

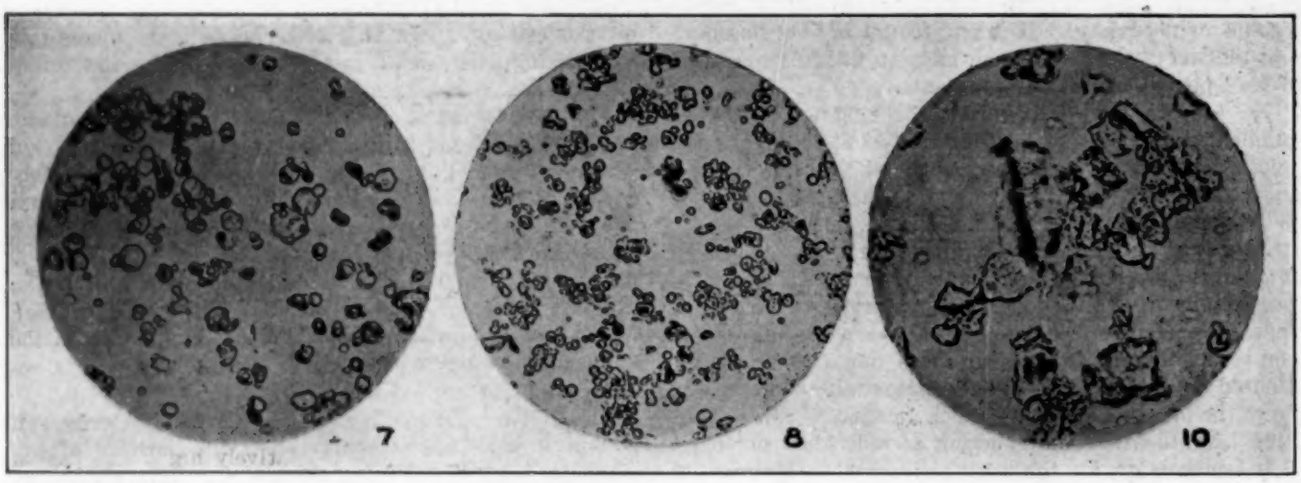


FIGS. 4, 5 AND 6

Fig. 4—French process zinc oxide, 1,500 diameters. There is less tendency here to form needles and twins than in the American process zinc oxide.

Fig. 5—Lithopone, 1,500 diameters. Note fine grain, different refractive indexes of particles and absence of any large particles.

Fig. 6—Lithopone, 1,500 diameters, taken with quartz lenses and ultra-violet light, showing clearly the transparent $BaSO_4$ as distinct from the opaque ZnS.



FIGS. 7, 8 AND 10

Fig. 7—Basic carbonate of white lead, 1,500 diameters, showing the characteristic hexagonal outlines of these crystals.
Fig. 8—Basic sulphate of white lead (sublimed white lead), 1,500 diameters. There is a slight tendency, not well shown in the photograph, for this pigment to form cubes.
Fig. 10—Barytes, 800 diameters.

Lithopone. Contrary to usual belief, lithopone is a fine-grain material, the average particle size falling between 0.3 μ and 0.4 μ. The misconception has arisen from the fact that lithopone rubs down in oil with a "pebbly" grain, but this should not be taken as an indication of the presence of large particles.

Under the microscope the material appears to be non-crystalline, the particles roundish in form, some having a high index of refraction and some low (Fig. 5). With the fluorescence microscope, sunproof lithopones appear dark, while the non-sunproof are beautifully fluorescent. Ultra-violet microphotographs show that these materials are composed of two ingredients, one transparent ($BaSO_4$) and the other opaque (ZnS) (Fig. 6).

Basic Carbonate of White Lead. On account of the large, well-defined hexagonal-shaped particles, this pigment is one of the best subjects with which to start in the study of pigment microscopy (Fig. 7). This material averages in particle size from 0.75 μ up to 2.0 μ and over, according to the method used in manufacturing it. When made by the Mathewson process, it is composed of large rough plates with a tendency toward the hexagonal outline.

White lead particles are never acicular, but always tabular. There are occasions, however, when this pigment contains elongated prisms of great size, but these are probably an impurity in the form of "normal" lead carbonate. Unlike zinc oxide, white lead is transparent to the ultra-violet wave length, 0.275 μ.

Basic Sulphate of White Lead (Sublimed White Lead). There is very little that is characteristic of this pigment. The particles are apparently non-crystalline, roundish in form, with here and there a tendency toward the cubical in form. The average particle size is about 0.65 μ (Fig. 8).

Gas Black. This substance is one of the most difficult subjects for microscopy (Fig. 9). This material can be successfully photographed only with the use of ultra-violet light. It is difficult for any one to see the gas black particle unless he possesses the trained eye of the microscopist. The individual particle does not look black, but slightly grayish or brownish, and seems to be more or less translucent. In size it is about 0.15 μ. Gas black has very strong tendencies to flocculate in all media and consequently it is not easy to obtain a well-dispersed mount of it. All gas black contains large lumps of undispersable material which are probably adamantine.

On the other hand, lamp black particles appear black under the microscope and are noticeably larger than those of gas black, about 0.3 μ to 0.4 μ. It is never possible to mistake one of these blacks for the other.

The Inerts. Barytes (Fig. 10), silica, asbestine and whiting (Fig. 11) are some of the principal inerts met with in paint and rubber. They are not difficult to recognize after the microscopist has become familiar with their characteristic features. In order to distinguish between barytes and silica it is sometimes a help to have on hand two liquid media of refractive indices of 1.54 and 1.64; silica is nearly invisible in the first and barytes in the second of these, giving an easy means for determining which material is being examined. Asbestine contains the characteristic rods of asbestos, though never so long as in the mineral itself. Whiting is easily recognized from the round "doughnut"-like shells of foraminifera which it contains.

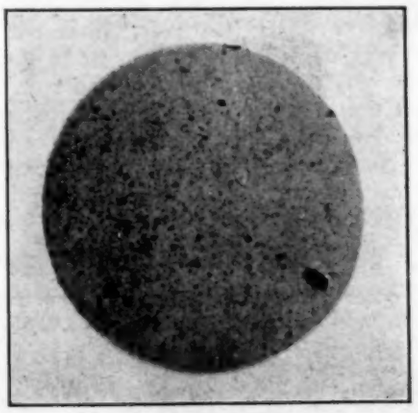


FIG. 9—GAS BLACK, 1,500 DIAMETERS
Taken with 1.7 mm. quartz monochromat and ultra-violet light.

The inerts possess such a low order of uniformity[3] that it is difficult to determine their particle size by the photomicrographic method, but as a rule they probably average from 5.0 μ to 10.0 μ in diameter.

[3] "A Photographic Method for the Determination of Particle Size of Paint and Rubber Pigments," by Henry Green, *J. Frank. Inst.*, November, 1922.

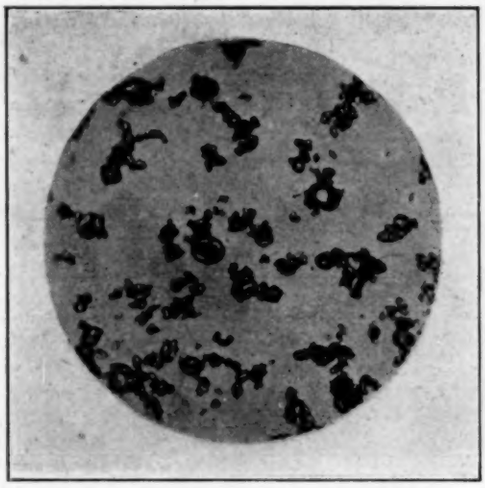


FIG. 11—WHITING, 500 DIAMETERS

Though the inerts are coarse in size, they are not "easy" subjects for the beginner, on account of their low index of refraction, making them difficult to see and impossible to photograph unless mounted in a medium of comparatively high refractive index.

Application to Research

When investigators finally become convinced of the fact that the ultimate working unit—the individual particle—can be seen and photographed through the microscope, then it should not be long before ways are found to apply the science of pigment microscopy to research problems.

The particle size of pigments is of the greatest importance to both the paint and rubber industries. In paint, particle size influences hiding power and consistency; in rubber, the resistance offered to abrasion. In order that as much guesswork as possible be eliminated from the estimation of particle size by the use of the microscope a method has been developed for the accurate measurement of pigment particles from negatives taken at a carefully ascertained magnification.[3] Prior to this research very little information as to the relative sizes of the common pigments was available. Investigators had made rough estimates of these for themselves, but they were admittedly only approximations and as a rule usually ran from 100 to 500 per cent too high. On the other hand, concerns manufacturing materials claimed to be colloidal often underestimate the particle size of their products to an even greater extent. Knowledge of proper methods for mounting pigments and the ability to use high-power lenses would soon correct these unnecessary misconceptions and pave the way for important advances in pigment technology.

Flocculation of Pigments

Perhaps one of the most important properties of pigments when incorporated in either rubber or paint vehicles, and one completely ignored until recently,[3] is that of flocculation. This property—or more correctly, the force which causes it—gives rise to the plastic nature of paints[4] and to the "stiffness" of compounded rubber. So far no microscopic method has been devised capable of giving more than a rough estimation of the magnitude of this force, but simple microscopic observation will always reveal its presence or comparative absence. In order to see it well in paints the material should be thinned with some of its own vehicle. This property depends entirely on the degree of wetting between the dispersed and continuous phases.

Flocculation of the pigment filler takes place in rubber, probably when its mobility is at its highest—that is, during vulcanization; the flocculates, having once formed, became permanent and can be studied in microsections made from the finished product. Rubber, of course, is plastic; consequently even when its mobility is high it still retains a yield value which, if greater than the force of flocculation of the filler, will tend to prevent the pigment particles from grouping. This is the case when rubber is compounded with zinc oxide. Here the wetting is of a comparatively high order, the flocculating tendency is weak, and the result is that microsections show very complete dispersion of this pigment in rubber.

The degree of wetting of the blacks by rubber is evidently low, for microsections show these pigments decidedly flocculated. It should be mentioned in this connection that poor incorporation of gas black will show as dense black lumps and should never be confused with flocculation, an entirely different phenomenon. Rubber microsections are made by first hardening the sample in a carbon tetrachloride solution of sulphur chloride,[5] or in melted sulphur,[6] or liquid air.[7] Sections are made from 0.5 μ to 5.0 μ in thickness according to the kind and quantity of pigment incorporated. Valuable information can sometimes be obtained from microscopic examination of stretched sheets of rubber instead of sections.[8]

Conclusion

Only three of the possible uses of pigment microscopy have been touched upon in this paper—namely, pigment identification, particle size measurement and the study of pigment flocculation. It requires very little imagination to visualize the innumerable problems which usually crop up during the course of a year's research on pigments, a large portion of which could be solved by the use of a knowledge of pigment microscopy. It has not been the intention, as stated earlier, to emphasize the application of this work to paint and rubber so much as to lay down the elementary principles upon which to erect a new science—the science of the microscopy of paint and rubber pigments, and as such, it is hoped, this endeavor will be found useful.

F. G. Breyer was, in all probability, the first investigator successfully to use the microscope in the study of zinc oxide. He recognized the crystalline nature of this material, which was supposed to be amorphous, and clearly distinguished between oxides made by different processes. At his suggestion the work, briefly given in this paper, was commenced about 6 years ago, and during that time has constantly received the benefit of his encouragement and enthusiasm, for which the author gives grateful acknowledgment.

Palmerton, Pa.

[3] "Pigment Flocculation—Its Relation to Paint Consistency," by Henry Green. Read before the September, 1922, meeting of the American Chemical Society.

[4] See Note 3. Also, "Further Development of the Plastometer and Its Practical Application to Research and Routine Problems," by Henry Green, A.S.T.M., vol. 20, Part II, 1920.

[5] "Recent Development in the Art of Rubber Microsectioning," by Henry Green, *J. Ind. Eng. Chem.*, vol. 13, No. 12, December, 1921.

[6] "The Microscopic Examination of Rubber Containing Antimony Pigments," by A. F. Hardmann. Read before September, 1922, meeting, American Chemical Society.

[7] "Some Microsections Cut From Vulcanized Rubber Articles," by H. A. Depew and I. R. Ruby, *J. Ind. Eng. Chem.*, vol. 12, 1920.

[8] "Volume Increase of Compounded Rubber Under Strain," Henry Green, *J. Ind. Eng. Chem.*, vol. 13, No. 11, November, 1921.

German Brown Coal Compared With American Lignite

Is Almost Two-thirds Water, Ours One-third; Has 2½ to 13 Per Cent Agglutinating Matter, Ours Less Than 1½ Per Cent

By O. P. Hood
Chief Mechanical Engineer, U. S. Bureau of Mines

ALTHOUGH I had read many reports about the brown-coal industry of Germany, actual inspection gave me several impressions for which I was not prepared. We had fallen into the careless habit of thinking about German brown coal and American lignite as similar material. The great briquetting industry which has been built upon German brown coal has been frequently pointed to as an example of what we should do with our own lignites. This puts one in a frame of mind to expect a greater similarity in raw material than actually exists.

Analyses of the two materials indicate a great difference in water content. Our lignite has approximately 35 per cent moisture, whereas German brown coal in the Cologne district has about 60 per cent. Along with this difference in the moisture content is a considerable difference in physical character. Brown coal is much more like earth than like rock. It is far less consolidated than our lignites. We would not think of trying to force a spade into a bed of our lignite, but this would be quite possible with much of the German brown coal.

Physical Characteristics

A piece of brown coal slightly consolidated and 3 in. thick is readily broken with the fingers like a piece of corn bread. Throughout a mass of brown coal small pieces of wood are much in evidence. The binding material between the annual layers of wood growth has almost disappeared, leaving the thin chips to curl and crumble when exposed to the sun. One small pile of brown coal exposed to the weather for a couple of months had the appearance of a chip pile.

These woody pieces had turned a dark chocolate brown, and they have various degrees of friability. Occasionally large chunks of wood are found that would offer considerable resistance to any digging device. The beds in various places vary in the proportion of fine and coarse material but in general the material is distinctly earthy. When taken to the briquetting plant the brown coal is passed over screens which take out pieces over about 3 in., and these are diverted to the boiler house for steam making.

The remaining material above ½ in. is readily broken up in a disintegrator. Our own lignite would have to be put through rolls or a jaw crusher. The vegetable growth that furnished these great beds varied from time to time, so that in some places there is a distinctly banded appearance, the color varying from various shades of chocolate brown to a light yellowish brown. In mining by hand the material is easily dislodged with pick and shovel. Blasting seems unnecessary, and the excavating machinery scrapes it off a steeply inclined face.

Our own lignite, however, is consolidated, so as to be quite comparable in hardness with our more familiar bituminous coal. It is mined in the same manner as is soft coal, by the use of coal-cutting machines and explosives. It usually occurs, also, in measures that have rock above and below, whereas in the German

Keystone View Co., Inc.

CHAIN BUCKET CONVEYOR DIGGING BROWN COAL IN THE NIEDER LEUSITZ DISTRICT

measures the overburden is sand, gravel and clay. These differences are responsible for the different methods of working. The greater part of German brown coal is taken from open pits by machinery.

There is a limit, of course, to the depth of the overburden, as compared with the thickness of the coal, that can be economically removed, and when this limit is exceeded underground mining methods are used. Those parts of the beds that can be worked from open pits are developed first, but as the industry grows older the deeper lying portions will be worked by underground mining at a higher cost.

Our own lignite can in places be stripped of the overburden by excavating machinery, and can be loaded into cars by the same machines. This work probably would be done by our standard dipper excavators, and machines of this type are to a limited extent used in brown coal, but the relatively easy digging together with the uniformity of material has led the German engineers to develop in high degree the chain bucket excavator for this work.

Chemical Differences

Besides these physical differences there are important chemical contrasts. Certain materials in brown coal, on being heated, form an excellent binder and waterproofing material. The temperature at which this material develops is well below that of the distillation of any of the other coal substances. The percentage of this binder in the raw material must be at least 2½ per cent if briquets are to be produced by the German method. This method, briefly, is to subject the brown coal, which has been dried to a moisture content of about 13 per cent, to high pressure, pushing it through a converging die which generates sufficient heat by friction to melt the inherent binder and thus waterproof each particle. Different brown coal beds possess this natural binder in varying quantities up to 13 per cent.

The low-temperature distillation of this material yields lubricating greases and paraffine from which candles are made. Most of our American lignites have binding material of this sort in quantities less than 1½ per cent. This immediately suggests that our own problem of briquetting is fundamentally quite different from that of the German brown-coal area. We are quite justified in looking to the development of the brown-coal industry as an excellent example of what can be done when it is necessary to beneficiate a low-grade fuel, but we are not justified in looking to

this example for specific technical detail as a solution of our own lignite problem.

America has a lignite problem that must be solved in our own way to fit our own raw material and to suit our own economic conditions. The German brown coal occurs in well-populated districts where there is a high degree of industrial development coincident with a scarcity and relative high price of other fuels. It is in the possession, also, of a people who have not always had the choice of an abundance of the best coal and who have already acquired an attitude of thriftiness toward the use of heat.

Our own lignite occurs in districts furnishing a far less concentrated market and a much smaller degree of industrial development, and where the distances from coal field to a market are much greater. Our lignite also occurs among a people quite familiar with some of the best coals on earth and with habits of using heat in quantity, particularly for domestic purposes, quite unknown to European habit.

The brown coal industry of Germany at the present time is rapidly developing, as a result of the scarcity of industrial fuel. There is a real shortage of fuel which can be met in the most expeditious manner by the development of brown coal. While a relatively small percentage of Germany's total fuel resources are in the form of brown coal, they are turning to this portion for rapid development at this time. There is enough of this material to last from eighty to a hundred years, and the methods of mining and treating have been developing since about 1856, so that practices are substantially standardized and can be applied with little risk and uncertainty.

In 1921 the total output of brown coal was 123,000,000 tons, while more than 28,000,000 tons of briquets were produced. The raw brown coal is used for industrial purposes on step grates, but since it has only from 3,200 to 4,500 B.t.u. per pound, it is quite evident that it cannot be transported any great distance, except under extreme need. The briquets, on the other hand, make a most excellent fuel for industrial and domestic consumption.

It takes about three tons of brown coal to produce one ton of briquets, one ton of the raw material being required to reduce the remaining two tons to one of briquets. Their heat value is about 8,600 B.t.u. per lb.

Platinum in 1922

During the first 9 months of 1922 the imports of crude and unmanufactured platinum amounted to 72,410 oz., which is nearly 11,000 oz. more than the imports during the whole of 1921. Colombia supplied about half the crude platinum that reached the United States, and some Russian platinum came in through England and other countries. As the domestic supply of platinum and related metals is now almost completely dependent on imports, it is reasonable to expect a considerable increase in the quantity of new metals recovered by refiners. Stocks of platinum at the beginning of the year were about normal, amounting to 64,547 oz.

The large supply was reflected in the price of refined platinum, which throughout most of the year was from $87.50 to $90 an ounce but which early in the fall advanced to $108. Palladium remained at $55 to $60 an ounce without fluctuation. The price of iridium was fairly regular at $160 to $175 an ounce until fall, when a shortage of supply caused a considerable advance in price.

Oxidation-Reduction Indicators

Dr. William Mansfield Clark, chief chemist of the Hygienic Laboratory, spoke before the Chemical Society of Washington, Dec. 14, on "Oxidation-Reduction Indicators" and gave a demonstration of equipment used.

The speaker gave a brief description of the method used in the study of the oxidation-reduction equilibria among organic dyes. Titrations were carried cut in a closed vessel under the protection of pure nitrogen. Electrode measurements were made against a saturated KCl calomel electrode and the single potential differences were reduced to the hydrogen scale. In all cases the dye solutions were buffered against change in hydrogen-ion concentration, as was also the titanous solution used for reduction.

It was shown that when the hydrogen-ion concentration was maintained rigidly constant the curves relating single potential differences to percentage reduction conformed to Peter's equation

$$E = E_o - \frac{RT}{nF} \log_e \sqrt{\frac{reductant}{oxidant}}.$$

The value of n, as this is determined from the slope of the curve, is found to be 2 in the case of all dyes so far studied. The accuracy obtained by this method was as high as has been observed in the study of inorganic systems. The speaker particularly emphasized the necessity of controlling the hydrogen-ion concentration in measurements of this type and then pointed out the shift which occurs in the equilibrium potentials on change of acidity. Unlike most inorganic systems which require for their favorable study intense acidities or intense alkalinities, many of the organic systems may be swung through the whole gamut of acidity-alkalinity. When so handled they reveal the influence of hydrogen-ion concentration in details which have hitherto not been appreciated. To illustrate this the speaker showed his extensions of the data on ferrocyanide-ferricyanide mixtures and on the quinhydrone system. Carrying this into regions of p_H which have hitherto not been studied, it was shown that there is an orderly transition from regions where p_H has no influence upon electrode potentials to regions where the potential varies in an orderly manner with p_H.

There was then developed the mathematical treatment outlined in the speaker's book, "The Determination of Hydrogen Ions," 2nd edition, Chapter XVI. By means of the mathematical relations it was predicted from the chemical nature of certain of the dyes that the curve relating the potential at 50 per cent reduction to p_H should have at 30 deg. various slopes in various regions of p_H. By assigning arbitrary acidic and basic dissociation constants, equations were developed which fitted the experimental facts, and the constants so assigned agreed with independent estimations where these are available.

Taking as an example the substituted indophenols, the influence of substitution upon equilibrium potentials is revealed, and a new method of studying the influence of substitution is opened up. Substitution in any one type of dye was shown to have relatively little effect, a greater effect being found in the transition from one type of structure to another.

By selecting a series of dyes, the equilibrium potentials of which have been determined, it is possible to construct a system of oxidation-reduction indicators comparable in their own field with the acid-base indicators.

The Low-Temperature Carbonization of Coal

II—Results of Applying the Carbocoal Process to Various Types of Coal in Small-Scale Apparatus

By Harry A. Curtis and Walter J. Geldard

In a previous paper[1] in this series the authors described the development of the Carbocoal process on a commercial scale at Irvington, N. J. In its final form this process consisted essentially of the three steps: first, carbonizing the coal at low temperature; second, grinding and briquetting the carbon residue, and third, carbonizing the briquets to render them smokeless. The Carbocoal process and the experimental plant at Irvington presently aroused a great deal of interest; inquiries began to come in from all parts of the United States, from England, France, Japan, Canada and elsewhere. Coal operators wanted to know whether their particular coals were suitable for making Carbocoal and what yields of byproducts could be obtained. In several cases carload lots of coal were shipped to Irvington and tested in the commercial retorts, but the cost of such tests was high and it was difficult to measure accurately the byproduct yields from a few carloads of coal. To meet the situation there was finally developed at Irvington a complete miniature plant in which the various steps of the Carbocoal process could be carried out with 100-lb. batches of coal. In the following pages this small-scale apparatus is briefly described and the results obtained with several typical coals is discussed.

Apparatus Used

Primary Carbonization—The low-temperature carbonization of the coal was carried out at 500 to 550 deg. C. in a cast-iron retort, shown in Fig. 1. This retort was mounted in a firebrick setting and heated by three surface combustion burners. In the early tests with this apparatus the paddle shaft was turned by hand, but later a motor drive was substituted. It will be noted in Fig. 1 that the retort is so designed that all the coal is within the heated area of the retort.

It was customary to carbonize three batches of coal of 33⅓ lb. each in this retort before disconnecting the byproduct apparatus. It would have been better to have had a larger retort and to have made a single charge of 100 lb.

Collection of Byproducts—The volatile matter distilled from the coal was passed successively through a condenser, a water scrubber, an exhauster, an acid scrubber and four wash-oil scrubbers, the residual gas passing to a holder. Arrangement of the apparatus is shown in Fig. 2. During the test, tap water was circulated through the condenser. One liter of water was placed in each water scrubber, 1 liter of 10 per cent H_2SO_4 in the acid scrubber, 1½ liters of wash-oil in each of the oil scrubbers. The wash-oil used was the ordinary high-boiling petroleum oil commonly used in byproduct coke plants. It was later shown by one of our co-workers[2] that, for the absorption of light oils from coal gas and for its subsequent analytical determination, absorbent charcoal is a much better, cleaner and more easily handled reagent. Accordingly, the four wash-oil scrubbers were removed and two tin tubes, in series, each containing 600 cc. of absorbent charcoal, were substituted. This change increased greatly the facility of setting up and handling the apparatus, as well as the accuracy of the analytical results.

During a run, tar and ammoniacal liquor collected in the condenser, the two water scrubbers, and a little in the sulphuric acid scrubber. The ammonia was distributed in the tar, the liquor, the water scrubbers and largely in the acid scrubber, while the light oil in the gas was removed by the wash-oil or charcoal scrubbers.

Briquetting—The carbon residue accumulated from the primary carbonization was ground to the proper screen in a small Hardinge ball mill, mixed with crushed pitch and then fluxed with live steam in a vertical fluxer. Briquets were made in a small Komarek press, the briquets being approximately the same size as made in the larger plant presses.

Secondary Carbonization—The briquets were carbonized at 1,000 to 1,100 deg. C. in a carborundum muffle 10 in. diameter by 36 in. length, the byproducts being collected just as during the primary carbonization of the coal.

Data Taken During Test

It is not possible in a brief paper to set down all the details of operating procedure with the small-scale apparatus described, nor to discuss all the precautions used in taking samples, in recording various measurements and in chemical analyses. It is perhaps worth while, however, to list below the items of information which each complete test yielded:

a. Proximate analysis, thermal value, ash fusing point, sulphur and nitrogen on coal tested.
b. Yield of gas, tar, ammonia and light oil during primary carbonization of coal and during secondary carbonization of the briquets.
c. Specific gravity and calorific value of primary gas and of secondary gas.
d. Specific gravity and distillation fractions for primary tar and secondary tar, with specific gravity and tar acid content of each fraction.
e. Yield of carbon residue and proximate analysis of same.
f. Screen analysis of carbon residue used in raw briquet mix, melting point of pitch used in same, and relative proportions of ingredients.

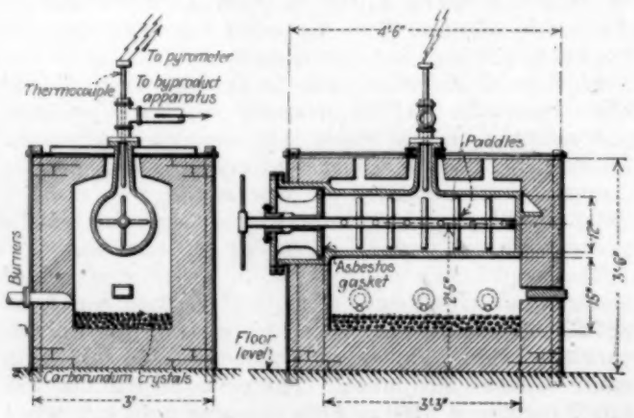


FIG. 1—SMALL-SCALE RETORT FOR LOW-TEMPERATURE CARBONIZATION

[1] *Chem. & Met.*, vol. 28, No. 1, Jan. 3, 1923, p. 11.
[2] A. L. Davis. Data not yet published.

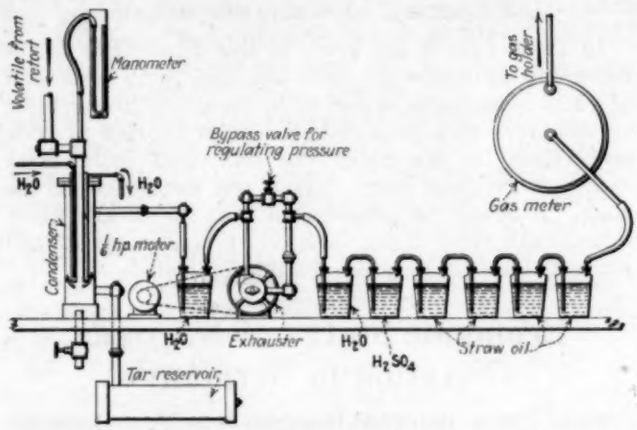


FIG. 2—APPARATUS FOR COLLECTING BYPRODUCTS DURING SMALL-SCALE TESTING OF COAL

g. Yield of Carbocoal and proximate analysis of same. Sulphur content, nitrogen content, calorific value, and usually a "drop test" of the Carbocoal.

The complete test of a coal in the small-scale plant described above came to be known in the company's records as the "Buffalo furnace test." There were something over 150 complete tests made at the laboratory at Irvington. It is not feasible to give the results of all these tests, but the attempt is made below to pick out various types of coals and summarize the data for these coals.

EXAMPLE 1. HIGH VOLATILE BITUMINOUS COAL

This particular coal was received as a carload shipment from the Russell mine of the Warner Collieries at Tiltonville, Ohio.

Item I—Proximate Analyses

	Coal As Rec'd	Coal Dry	Carbon Residue Dry	Carbocoal Dry
Moisture, per cent	4.5	.....	.....	.....
Volatile, per cent	37.4	39.2	8.9	4.4
Fixed carbon, per cent	47.4	49.6	75.0	77.7
Ash, per cent	10.7	11.2	16.1	17.9
	100	100	100	100
Sulphur, per cent		4.75	.....	2.06
B.t.u.		13,483	.....	11,551
Ash fusing point, deg. F.		1,810 to 1,840	.....	.....

Item II—Raw Briquet Data

Distribution of the 2,000 lb. of coal in process: 1,846 lb. coal (dry) to primary retorts and 154 lb. of powdered coal (dry) used in raw briquet mix.
Composition of raw briquets: Carbon residue, 80 per cent; powdered coal, 10 per cent; coke-oven pitch, 10 per cent.
Melting point of pitch, 170 deg. F.

Item III—Yields Per 2,000 Lb. Dry Coal

	Primary Carbonization	Secondary Carbonization	Total From Process
Carbon residue, lb.	1,234	.....	.....
Carbocoal, lb.	.....	.....	1,223
Dry tar, gal.	33.40	5.35	38.75
Ammon. sulphate, lb.	10.2	9.9	20.1
Light oil from gas, gal.	.....	.....	2.02
Gas, cu.ft.	3,622	3,690	7,312

Item IV—Gas Data

	Primary Gas	Secondary Gas	Total From Process
B.t.u. (average)	893	379	633
Sp.gr. at 60 deg. F.	0.65	0.59	0.62

Item V—Tar Data

Fractions	Primary Tar Sp.gr. 1.05 Vol., Per Cent	Sp.Gr.	Tar Acids, Per Cent	Total Tar From Process Sp.gr. 1.07 Vol., Per Cent	Sp.Gr.	Tar Acids, Per Cent
0-170 deg. C.	4.77	0.824	11.5	4.20	0.824	11
170-230 deg. C.	16.76	0.938	37.5	14.55	0.938	38
230-270 deg. C.	14.90	0.992	59.0	13.75	0.992	58
270-300 deg. C.	8.17	1.006	32.5	7.93	1.006	29
300 deg. pitch	7.04	1.068	30.0	10.29	1.053	18
Pitch (170 deg. F.M.P.)	48.36	.....	.....	49.81	.....	.....

TABLE I—GENERAL RESULTS WITH MISCELLANEOUS COALS

Test No.	Source of Coal	H_2O in Coal	Analysis of Coal On Dry Basis Vol.	F.C.	Ash	B.t.u. in Coal	B.t.u. in Carbocoal	F.P. of Ash, Deg. F.	Yields Per Ton of Dry Coal Semi-carbo.	Carbocoal	Dry Tar	Light Oil	Coal Am. Sulph.	Gas	B.t.u. of Gas	Sp.Gr. of Tar	Distillation of Dry Tar Percentages by Volume 0-170	170-230	230-270	270-300	300-End Pitch	175 Deg. F. Pitch	Analysis of Carbocoal Vol.	F.C.	Ash	Name of Coal or Mine or Seam
		Per				Per																				
		Lb.	%	%	%	Lb.	Lb.	Deg. F.	Lb.	Lb.	Gal.	Gal.	Lb.	Cu.ft.	Cu.ft.		%	%	%	%	%	%	%	%	%	
116	Wilder, Va.	2.2	35.3	56.5	8.2	14,225	12,458	2,300	1,393	1,543	29.1	2.2	19	7,644	640	1.07	2.7	14.3	11.6	9.5	20.2	41.7	6.2	79.4	14.4	Clinchfield Mine 6
120	Japan	1.6	39.2	55.8	5.0	13,883	11,055	2,240	1,281	1,387	33.9	2.46	16	8,890	602	1.06	4.6	13.9	12.2	9.6	16.3	43.4	4.9	82.3	12.8	Takashima Coal
131	Upshur Co., W. Va.	1.3	34.9	57.4	7.7	14,110	12,950	2,550†	1,281	1,346	32.55	1.09	18	7,553	581	1.08	....		Tar not distilled				4.9	81.7	13.4	Upper Freeport
132	Dawdon Col., Eng.	2.8	33.6	63.2	3.2	14,900	12,945	2,000	1,290	1,308	34.66	1.52	16	8,701	622	1.05	....		Tar not distilled				3.2	88.5	8.3	Low Main Seam
134	Maher Collieries	5.1	40.7	49.8	9.5	12,560	12,309	1,840	1,240	1,301	41.19	1.99	17	8,255	615	1.09	4.3	14.1	12.5	10.7	4.8	53.6	3.6	80.2	16.2	Maher Mine 9
137	Monteceau, Fr.	4.1	31.9	57.9	10.2	14,018	.....	2,320	1,300	1,356	27.02	1.48	14	7,846	621	1.10	3.2	10.9	11.2	8.8	13.2	52.7	6.0	80.7	13.3	Blanzy Coal
145	Lundale, W. Va.	1.2	32.9	61.8	5.3	14,481	13,419	2,640†	1,324	1,404	34.73	1.83	21	9,070	573	1.07	....		Tar not distilled				3.8	87.0	9.3	Cedar Grove Mine
130	Edmonton, Can.	18.2	38.9	46.4	14.7	10,315	.....	1,980	1,282	1,347	9.46	0.95	21	7,420	368	1.07	....		Tar not distilled				6.7	71.5	21.7	Medicine Hat Lignite
146	Rock Springs, Wyo.	10.4	42.8	54.0	3.2	13,117	13,364	1,985	1,240	1,125	31.04	1.84	34	9,345	487	1.06	4.2	13.1	11.7	12.8	8.2	50.0	4.1	89.7	6.2	U. P. Mine 10, Seam 7
128	Japan	14.1	45.0	34.5	20.5	10,202	9,377	2,280	1,188	1,183	34.22	1.82	25	9,722	525	1.02	2.5	14.4	15.6	13.0	11.4	43.1	7.9	61.8	30.3	Ibaraki Lignite
114	Bush, Ill.	5.4	34.6	48.8	16.6	12,329	12,096	1,990	1,356	1,373	24.54	1.64	19	7,871	541	1.12	4.8	14.0	13.2	12.0	4.8	51.2	3.9	77.3	18.8	Western Coal & Min. Co.
129	Neff, Ohio	2.9	39.3	49.7	11.0	12,906	11,195	1,790	1,205	1,285	37.12	2.79	21	6,835	608	1.10	3.1	12.1	13.0	10.6	9.8	51.4	4.3	78.6	17.1	Maher Collieries
138	Silksworth Col., Eng.	3.0	30.9	59.1	10.0	13,568	12,450	1,980	1,353	1,403	26.64	2.05	14	8,924	510	1.10	....		Tar not distilled				2.3	82.5	15.2	Duff Coal, Maudlin
148	Welbeck Col., Eng.	3.7	34.6	50.7	14.7	13,070	11,320	2,010	1,367	1,404	25.39	2.13	30	9,080	571	1.09	....		Tar not distilled				3.7	77.2	19.1	New Hucknall Slack
147	Cramlington, Eng.	9.3	37.3	54.4	8.3	13,298	12,249	1,925	1,329	1,331	27.78	1.2	32	9,288	432	1.10	....		Tar not distilled				4.6	81.6	13.8	.....
143	Gleba Col., Eng.	1.5	38.8	59.2	2.0	15,050	.....	2,080	1,295	1,274	34.02	1.72	32	8,870	515	1.14	....		Tar not distilled				4.7	90.7	4.6	Holly Lane, Fenton

Remarks:
Test No. 130—Briquet mix: 78 per cent semi-Carbocoal, 12 per cent coke-oven pitch, 10 per cent bituminous coal.
Test No. 131—Briquet mix: 80 per cent semi-Carbocoal, 10 per cent coke-oven pitch, 10 per cent bituminous coal.
Test No. 128—Briquet mix: 80 per cent semi-Carbocoal, 10 per cent Ibaraki pitch, 10 per cent bituminous coal.
Fusing point of ash: Values given are lower limits of fusing range.

Example 2. Texas Lignite

This particular sample of lignite was sent in by the Big Lump Lignite Co. from Rockdale, Tex. The results given below are of particular interest just now, since a plant is being built to carbonize and briquet this lignite.

Item I—Proximate Analyses

	Coal		Carbon Residue	Carbo-coal
	As Rec'd	Dry		
Moisture, per cent	29.4	.....	.....	.....
Volatile, per cent	32.7	46.3	13.2	7.7
Fixed carbon, per cent	30.1	42.7	69.3	74.2
Ash, per cent	7.8	11.0	17.5	18.1
	100	100	100	100
Sulphur, per cent	....	1.12	1	1
Nitrogen, per cent	....	1.45	1.5	.....
B.t.u.	....	12,155	.....	10,541

Item II—Raw Briquet Data

Composition of raw briquet mix:

Lignite carbon residue	80
Powdered coal (coking coal)	10
Coke-oven pitch	10

The pitch from lignite is not suitable for binder if used alone, but can be used if it is blended with asphalt or with coke oven pitch.

Item III—Yields per 2,000 lb. Dry Lignite Plus the Powdered Bituminous Coal and Extra Pitch Used in Raw Briquets

	Primary Carbonization	Secondary Carbonization	Total From Process
Carbon residue, lb.	1,143	.....	.....
Carbocoal, lb.	.....	.....	1,091
Dry tar, gal.	13.67	7.17	20.84
Ammonium sulphate, lb.	11.75	6.70	18.45
Light oil from gas, gal	.....	.....	2.61
Gas, cu.ft.	6,475	4,651	11,126

Item IV—Gas Data

	Primary	Secondary	Total
B.t.u. of gas	603	291	473

Example 3. Medium Volatile, High-Ash, Bituminous Coal

This sample came from the Snowdown Colliery, near Dover, England.

Item I—Proximate Analyses

	Coal		Carbon Residue	Carbo-coal
	As Rec'd	Dry Basis	Dry Basis	Dry Bas
Moisture, per cent	2.3	.....	.....	.....
Volatile, per cent	24.6	25.2	7.6	4.5
Fixed carbon, per cent	55.8	57.1	68.4	72.2
Ash, per cent	17.3	17.7	24.0	23.3
	100	100	100	100
Sulphur, per cent		3.4	.....	1.62
Nitrogen, per cent		1.9	.....	.....
B.t.u.		12,462	.....	11,358
Ash fusing point, deg. F.			1,980 to 2,020	

Item II—Raw Briquet Data

Distribution of coal in process: to primary retorts, 1,785 lb.; to raw briquet mix, 215 lb.

Composition of raw briquets:

Carbon residue, per cent	78
Pitch, per cent	10
Powdered coal, per cent	12
	100

Item III—Yields per 2,000 lb. Dry Coal

	Primary Carbonization	Secondary Carbonization	Total From Process
Carbon residue, lb.	1,396	.....	.....
Carbocoal, lb.	.....	.....	1,505
Dry tar, gal.	16.3	7.5	23.8
Ammonium sulphate, lb.	5.1	10.1	15.2
Light oil from gas, gal.	0.83	0.32	1.15
Gas, cu.ft.	2,552	5,019	7,571

Item IV—Gas Data

	Primary Gas	Secondary Gas	Total
B.t.u.	851	348	518
Sp.gr.	0.625	0.57	0.59

Item V—Tar Data

Sp.gr. of primary tar	1.062
Sp.gr. of secondary tar	1.181

Distillations not made.

Example 4. Miscellaneous Coal

In Table I there are given in less detail than in the foregoing examples the data obtained with a variety of coals. The table is meant to show only the general results from such coals and should not be used to draw conclusions by comparing the individual coals, since each test involved many details not mentioned in the table. It should be remembered that the results given in this table refer to the Carbocoal process complete and not to the low-temperature distillation alone.

Economic Status of Nitrogen Fixation in Germany

Present Production Still Inadequate to Meet Domestic Requirements—Recent Developments Compared With Pre-War Situation*

By W. T. Daugherty

Assistant Trade Commissioner, U. S. Bureau of Foreign and Domestic Commerce

THE importance of synthetic nitrogen for Germany's agriculture as well as for her industries is greater now than before the war. The present financial condition of that country prevents her purchasing Chilean and Norwegian nitrates in great quantity as she did in 1913. Furthermore, the necessity for increased domestic production of foodstuffs to free Germany from foreign supplies, for which she can ill afford to pay at present world-market prices, is now much more pronounced.

The result is a consistent effort to increase the fixation of nitrogen from the air—an effort which had its first real impetus when Germany went to war and was automatically cut off from importing Chilean nitrates. Germany's experience with nitrogen fixation has thus far been highly satisfactory, certainly from the standpoint of meeting the emergencies for explosive manufacture created by the war and the demands for the progressively intensive agriculture after the war. Although crop statistics for the past year, compared with 1921, would seem to belie an increase in the use of artificial nitrogen fertilizer, the real reason for the decrease in agricultural yields is probably to be sought elsewhere. German crops suffered from unfavorable weather this year and nitrogenous rehabilitation is still much needed to compensate for previous neglect resulting from the demands made by the ammunition industry on war-time artificial nitrogen production.

Germany's comparatively new synthetic nitrogen industry, as developed most efficiently by the inventions of Haber and Bosch, must be regarded as a very important scientific achievement, likely to compete in the world market of the future against native nitrate salts, as well as against the air-fixed products of Norway and Switzerland.

The Supply in 1921-1922

German production in terms of nitrogen content in the fertilizer year[1] 1921-22 amounted to 300,000 tons, according to the most reliable estimate, while the needs of agriculture and industry are estimated at from 500,000 to 600,000 tons. Two-thirds of this production was credited to the two plants employing the Haber-Bosch process for the production of synthetic ammonia,

*Special report No. 35, dated Nov. 7, 1922, at Berlin, Germany.

[1]The German fertilizer year begins on May 1.

from which, with the aid of catalyzers, nitrate salts are produced. The nitrogen content of these salts is estimated at about 20 per cent, which indicates a production of 1,000,000 tons. One-sixth of the 1921-22 production of synthetic nitrogen in Germany is credited to the Frank-Caro process yielding calcium cyanamide (19 per cent N) for commerce, and an equal share belongs to the coke and gas factories, yielding ammonium sulphate (20 per cent N). The total production in 1921-22 was about 41 per cent above production in the previous year, and the ratio of increase was more or less uniformly distributed among the three processes of manufacture.

According to official statistics, the consumption of fixed nitrogen by German agriculture alone was 300,000 tons natural organic, but this included other nitrogenous fertilizers not discussed here. The German industries—e.g., dyes, sulphuric acid, celluloid, meat preserving, etc.—are accustomed to use about one-fifth of Germany's nitrogen supply. Net imports of Chilean and Norwegian saltpeter during the 1922 fertilizer year amounted to 17,768 tons of salts, equivalent to about 2,500 tons of nitrogen, accordingly but a fraction of the needs of the industry.

Pre-War Nitrogen Supply

Before the war, Germany imported more than half of her total supply of nitrogen. In 1913, her net imports of nitrates from Chile amounted to 746,811 tons of salts (containing roughly 120,000 tons of nitrogen) and from Norway, Switzerland and Sweden 48,141 tons of salts (containing roughly 6,000 tons of nitrogen). In this connection it must be remembered that the actual value of nitrates as plant food is somewhat greater than that of ammonium sulphate, although the latter contains a relatively higher percentage of pure nitrogen. The superiority of nitrates lies in the readier assimilation of their nitrogen by plant life. The ratio of their assimilation, as compared with that of ammonium sulphate, has been computed[2] as 100:98.

In the fertilizer year 1913-14 Germany produced about 110,000 tons of pure nitrogen from the operations of her coke and gas factories, about 5,000 tons by the Frank-Caro method, and about 7,000 tons by the Haber-Bosch process. The latter process was then in its infancy, while the former, now as then, is less economical, at least when dependent upon the power sources for electrical energy which Germany is able to offer.

Germany's gross supply of nitrogen for argiculture and industry in the calendar year 1913 (Note: The above production figures were for the "fertilizer year") was approximately 248,000 tons. Agriculture absorbed 210,000 tons of this amount, the remainder being used by industry. By similar computations, it is calculated that Germany's gross supply of nitrogen in 1912 was approximately 230,000 tons, with a similar ratio of consumption by agriculture and industry, and in 1911, about 185,000 tons.

It is interesting to note the increase in the use of synthetic nitrogen in Germany in the last 10 years. Besides having the poorest soil of any of the larger nations of Europe, Germany now has new difficulties in feeding her dense population, because of inability to buy abroad on a pre-war scale. Dr. Caro, head of the Bayerische Stickstoffwerke at Trostberg, which employs the process bearing his name (and also operated in America), has stated that if Germany's annual production of synthetic nitrogen is increased to 500,000 tons of nitrogen she can be freed from importing foreign grain. Others estimate that 600,000 tons would be required. It is assumed that Dr. Caro presupposes that German soil would also be adequately supplied with potash and phosphates, but even so his estimate seems very optimistic.

In connection with the general fertilizer situation, it is stated that German soil was overfed with phosphates before the war and that sufficient reserves are in the soil to allay any fears of an imminent phosphate shortage. The average ratio of nitrogen to phosphate and potash absorption by all German crops is estimated at 1 to ½ and 1 to 1½ respectively.[3]

The War Developments

The war revolutionized Germany's supply of nitrogen by building up a fixation industry. The process was by no means unknown when the war broke out. The arc process of producing nitric acid was already in use. Frank and Caro had discovered calcium cyanamide, and Haber and Bosch had perfected their process of producing ammonia by the direct combination of hydrogen and nitrogen.

It was the latter process that was destined to grow from small beginnings to the greatest single enterprise of its kind in the world. The Oppau plant, at Ludwigshaven-am-Rhein, operated by the Badische Anilin und Soda Fabrik, is now credited with an annual capacity for production of 100,000 tons of nitrogen; the Leunawerke at Merseburg with 200,000 tons. Probably only Germany's acute coal shortage and the explosion in the Oppau plant on Sept. 21, 1921, prevented capacity output in 1921-22.

The Situation in 1914

Germany had about 50,000 tons of combined nitrogen when she entered the war. Reserve stocks of Chilean nitrates contained about 25,000 tons; ammonium sulphate, about 20,000 tons, while about 5,000 tons was captured in Belgium, northern France and in the East during the first invasions. Relatively small amounts were imported from Norway and other neutrals. She was potentially able to produce 122,000 tons, 110,000 tons alone being from her byproducts coke and gas manufacture. The German steel industry, however, suffered a setback at the beginning of the war, so that this source of supply was diminished to about 65,000 tons in 1914-15. From her visible resources, Germany, then, was able to rely on 130,000 tons of nitrogen during the first year of the war. Her minimum requirement in 1914-15, it has been estimated, was between 200,000 tons and 220,000 tons to meet the needs of (1) the army and navy, for the manufacture of ammunition, (2) agriculture and (3) industry. The manner in which she developed her own resources in an endeavor to meet this demand affords one of the most interesting chapters in the history of science.[4]

It goes without saying, however, that the prior claims made on Germany's nitrogen supply by the ammunition industry during the war affected agriculture unfavorably, and that from the first year of the war German soil was progressively inadequately fertilized with nitrogen.

The main burden of responsibility for increased syn-

[2] "Stickstoffduengenmittel," by Chemicker Dr. Harter, 1919. Fraenkische Ges. Druckerei, Wuerzburg.

[3] Gerlach, "Die Ernaehrung der Landwirtschaftlichen Kulturpflanzen im Zeichen des Phosphorsauermangels," 1919. Die Deutsche Landwirtschaft Gesellschaft, vol. 300, p. 79.

[4] Discussed in "Die Stickstoffversorgung der Welt" by Walter Eucken, published in 1921 by "Deutsche Verlags-Anstalt," Stuttgart and Berlin.

thetic nitrogen production fell upon the two processes of Haber and Bosch and of Frank and Caro. The Oppau plant was already in operation, and it was immediately enlarged. The Leunawerke was erected in 1917 as an extension on the brown coal deposits in the Halle district, where cheap power was available. The Frank and Caro process was in operation at Trostberg, where the Bayerische Stickstoffwerke had its plants. Extensions for the emergency created by the war were created at Knapsack-bei-Köln; Gross Kayna, bei Halle; Waldshut; Piesteritz, and Chorzow, in Upper Silesia (since lost to Poland), all using the Frank and Caro process.

Production During the War

It was estimated that all of these plants working at capacity would be able to cover Germany's demand sufficiently to meet all exigencies. With the adoption of the Hindenburg military program in 1916, first estimates of Germany's need were far surpassed and production was, in consequence, always insufficient. It is interesting to note that the first year's estimated need of the army and navy, amounting to 50,000 tons, increased eventually, with the extension of military operations, to approximately 240,000 tons annually. Production lagged behind this estimate, the 1916-17 output being approximately 100,000 tons from coke and gas manufacture, 58,000 tons from Frank and Caro plants, and 64,000 tons from Haber and Bosch plants, or a total of 222,000 tons. This amount was increased in 1917-18 to a total of 271,000 tons, 100,000 tons being from coke and gas plants, 105,000 tons from Haber and Bosch plants, and 66,000 tons from Frank and Caro plants.

Future of the Industry

Production of fixed nitrogen in the fertilizer year 1922-23 will probably amount to 350,000 tons, or an increase of by 50,000 tons over the previous year. The main burden of production, as in the year past, will fall upon the Haber-Bosch process, which, as has been said, produced two-thirds of Germany's total output last year. While it is difficult to gage future competition of Haber-Bosch salts with natural nitrates, the costs of these salts on the inland markets are now much less than world market prices, so that for the present and immediate future the process represents a substantial economy.

That production costs can be kept down to the present level indefinitely is unlikely. All of Germany's synthetic nitrogen plants are located purposely on or alongside of natural sources of power, as for instance, the Leunawerke on the brown coal fields of the Halle District and the Trostberg works beside the swift current of the River Alz in Bavaria. Cheap and abundant power is a prerequisite for the development of the industry.

Calcium cyanamide manufacture, on the other hand, does not appear to have as promising a future. It depends upon the utilization of electrical energy, which is not as cheap in Germany as, for instance, in Norway and Switzerland. All in all, calcium cyanamide manufacture for fertilizer in Germany must be considered rather as an emergency enterprise made necessary by the war, and to a certain extent, as a less desirable but much-needed fertilizer during Germany's post-war reconstruction period, while she lacks ability to purchase the better nitrates on the world-market.

In order to cover the spread between an estimated 1922-23 inland production of about 350,000 tons of nitrogen and an estimated need of from 500,000 to 600,000 tons, Germany would have to import from 900,000 to 1,500,000 tons of 16 per cent nitrates in order to meet her maximum demand. Negotiations are reported to be in progress now among the government, agricultural interests and the trade to determine how far it will be possible to import "several hundred thousands of tons" of Chilean nitrates as a spring order for German soil. In case the government comes to the conclusion that it can make this investment, the trade has already promised to rush its order for spring fertilizing. If it were possible to do this, the claim is made that later Germany would not have to import any foreign grain, or at least only relatively small quantities, for the feeding of her population. All predictions of agricultural self-sufficiency, however favorable the fertilizer situation may become, must, however, be taken with great reserve.

Irrespective of any large purchases of Chilean nitrates that Germany may be obliged to make this year or next year, it is most probable that the former German market is permanently lost, and Chilean producers will doubtless seek a compensating market in the United States or elsewhere.

Manganese in 1922

Manganese ore containing 35 per cent or more of manganese shipped from domestic mines in 1922, according to figures compiled by the United States Geological Survey from reports of producers of manganese, amounted to about 13,500 gross tons, valued at $457,000. The ore of this grade shipped in 1921 amounted to 13,531 gross tons, valued at $495,097. The figures for 1922 represent the actual production for 11 months plus an estimate of the production in December. More than 10,000 tons of this ore was mined in Montana.

The new tariff act, which became effective Sept. 21, 1922, provides for a duty of $8 a ton on ore containing 40 per cent of manganese, $9 a ton on ore containing 45 per cent of manganese, $10 a ton on ore containing 50 per cent of manganese, and so on. Manganese should therefore bring an average price on the eastern seaboard amounting to the present average price of foreign ore plus about $9 a ton. The new tariff has not yet greatly affected the domestic manganese market, for even under its provisions not many domestic mines can be operated at a good profit; but the owners of mines that have heretofore been worked profitably have shown a renewal of interest in the industry, and some of the mines that are already developed and that yield ore of high grade will probably be reopened.

About 352,000 gross tons of ore containing 10 to 35 per cent of manganese, valued at about $1,232,000, was mined in 1922, as compared with 8,439 gross tons, valued at $42,755, in 1921. About 308,000 tons of ore of this grade shipped in 1922 was mined in Minnesota.

About 251,000 gross tons of ore containing 5 to 10 per cent of manganese, valued at about $630,000, was shipped from domestic mines in 1922, as compared with 62,670 gross tons, valued at $147,576, in 1921. About 248,000 tons of the ore of this grade shipped in 1922 was mined in Minnesota.

Up to Sept. 21, manganese ore amounting to 266,969 gross tons, valued at $2,324,989, had been imported into the United States in 1922, most of it from Brazil.

Cored Crystals and Metallic Compounds

Each Cored Dendrite Contains Many Small Crystals With Similar Lattices but Slightly Differing in Composition and Dimension—Intermetallic Compounds Usually Have Complex Lattices Giving Little Opportunity for Slip, Hence Are Brittle

By Edgar C. Bain, M.Sc.
General Electric Co., Cleveland, Ohio

THE history of the solidification of binary alloys which form solid solutions over a range is such an important factor in their structure that it may be well first to review briefly the current views on what takes place when a melt of a single pure metal solidifies.

Mechanism of Solidification From Melt

When a metal is retained above its melting point, its atoms (or molecules composed of two or more like atoms) are isotropic, so far as is known. A melt cannot be said to possess directional properties. It is true that some bodies have been studied[1] which exhibit such slight rigidity that they could not be thought of as anything other than liquids, but which do have the anisotropic properties of crystalline bodies to a discernible extent. On the other hand, the glasses are not crystalline and are isotropic, but possess great rigidity; they must, therefore, be classed as liquids of enormous viscosity. If we omit these two exceptional types of substances, we have rigidity and anisotropy as the outstanding properties of solids.

Fortunately these two "borderland" types are not known in metals. When the liquid metal cools to its freezing temperature, the atoms become anisotropic. If two or more like atoms are associated as a molecule in the liquid, they separate before solidification and perhaps in so doing acquire directional properties. If these centers of newly acquired properties form within the melt with sufficient speed the whole mass becomes crystalline even during a very rapid fall in temperature such as a quench from the molten state. Metals act in this way. In a few "solid amorphous" bodies we know, such as silicate, these centers cannot form rapidly upon cooling. Lowered temperature brings on a molecular sluggishness or viscosity which prevents rearrangement of the atoms and the isotropy is retained when the mass is very rigid.

It is well to remember that the molecule loses its identity in the solid state. It may well be that in liquid NaCl one chlorine atom may be bound more or less permanently to a certain sodium atom and remain thus coupled except as some electromotive force causes a transfer, but in the solid state there is no assurance that any particular combination represents a molecule. In solid NaCl any one sodium atom has equal chances of pairing off with six different chlorine atoms all equally remote and nearer than any other atoms, as can be seen in Fig. 1.[2] Similarly, if we regard the beta brass range as depending upon the compound CuZn (as noted in the previous contribution[3] on "The Nature of Solid Substances," crystallizes in the body-centered cubic system), each copper atom has equal chances of combining with eight surrounding zinc atoms for a molecule of CuZn.

The number of nuclei which form in unit time in relation to the rate at which they grow determines the grain size. In metals the number of nuclei which form in a quenched specimen is so great that a very fine structure results when a melt is poured into cold water. Yet even here the whole mass is largely crystalline; X-rays are diffracted surprisingly well by even these tiny planes which form the three dimensional grating. It is quite likely, however, that the grain size may well be in the colloidal range.

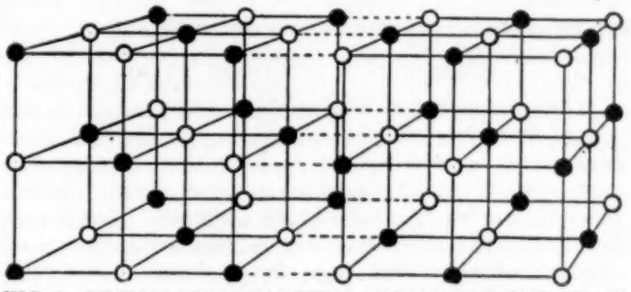


FIG. 1—SIMPLE CUBIC PATTERN OF SALT CRYSTAL (NaCl)

On the other hand, the opposite extreme is possible. If a crucible of melted metal is maintained accurately just above its melting point, a single crystal touches the surface and provision is made for a slow conduction of heat so that the point of contact of liquid and solid is very slightly below the freezing point, no new nuclei form, but the crystal grows by addition of atoms from the melt. If now this single crystal be elevated and slowly removed from the melt at a carefully chosen rate, the crystal will grow at the same speed and a rod as long as desired can be produced with but one orientation present—it is a single crystal.

Amorphous Metal

In the last analysis absolutely perfect crystallinity cannot be said to obtain in any piece of metal containing many polyhedral grains. Even when entirely pure there is some of the metal which does not have the regular atomic spacing of the normal crystalline body. This portion lies in the grain boundaries. It is commonly spoken of as amorphous metal. This expression probably describes quite well the condition of the thin zone of metal at the common boundary of two grains. When we consider that an atom retains its position in a space-lattice not alone by its own properties but by the established directional forces of all its neighbors, we are forced to postulate a zone of compromise existing between grains of unlike orientation. A "space-lattice distortion gradient" is formed between the two grains, and since the atoms are not in the normal relation to one another, then the arrangement is in many respects amorphous, although caused by and following definite force relations. This strained condition of the interatomic balance alters its electrochemical properties. Indeed, it is quite likely that the surface of any crystal has an altered structure to a depth of several atom rows or layers, since it is the common boundary of two unlike media. The author believes that the depth of the distortion zone—or in effect, the width of a grain

[1] "Liquid Crystals. Die Struktur Flüssiger und Welcher Kristalle beim Fliessen," O. Lehmann, *Z. Metallkunde*, vol. 13, Nos. 3, 4 and 5.

[2] From "The Non-Molecular Structure of Solids," by Arthur H. Compton, *J. Frank. Inst.*, June, 1918, p. 745.

[3] *Chem. & Met.*, vol. 28, No. 1, Jan. 3, 1923, p. 21.

boundary—is a function of the *absolute* elastic limit of the material. In squeezing and pulling apart the atoms, so as to change gradually from one orientation to another, no single atomic spacing can exceed a limiting value; therefore a space sufficient for the purpose must be used up. Possibly in no case is it necessary to use more than a few hundred atom rows for this zone of readjustment, and perhaps much fewer for two grains whose orientations are not greatly different.

Solidification of Binary Alloys

When a melt of two mutually soluble metals is permitted to cool to the freezing point, we find the atoms arranging themselves in a space lattice starting from many nuclei, exactly as does a pure metal. In this space lattice we find both kinds of atoms. But a complication arises. The first crystallites are richer in the higher melting metal than is the melt. This well-known behavior is depicted in the constitution diagram by liquidus and solidus lines. It should be remembered that these lines represent only the equilibrium condition: if considerable time is allowed for cooling, the first precipitated solid metal constantly changes its constitution by diffusion and grows richer in the metal of lower melting point until, when the last trace of liquid (now very rich in the lower melting metal) is solidified, the solid is uniformly of the original composition of the melt.

But it is very difficult to get such a condition except with extremely slow cooling. Actually the first deposited crystallites of dendritic structure cannot diffuse out their excess of higher-melting metal rapidly enough to maintain homogeneity with successive additions of new composition. Hence, the composition of the diminishing liquid phase grows inordinately richer and richer in the low-melting element and accordingly aggravates the disparity in composition of successive layers of deposited solid. (An alloy whose composition corresponds to a minimum in a solid solution, where the liquidus and the solidus are tangent, solidifies precisely as a pure metal and the phenomenon of coring does not occur.)

In a cast metal exhibiting marked coring we discover usually a very comprehensive network of the first solidified material. This is a result of the directional tendency of grain growth: long spars of the crystals shoot out into the melt. The interstices fill in later. This effect can often be observed on the surface of metals which shrink greatly upon solidification—the first network formed is left high above the surface last to freeze.

The fundamental or primary grains of such cored structures are quite easily seen by etching—the boundaries either appear as dark lines, or there is an abrupt change in the orientation of the rectilinear streaks of the differently etched compositions. Frequently there is a very sharp demarcation of the coring, almost as if an abrupt change of chemical composition occurred or a new phase appeared. The action of chemical reagents on solid solutions varies quite rapidly with change in composition in the metal, so that no new phase need fill in the interstices between the primary dendrites to cause this appearance.

But when these large-cored grains are examined by the X-ray spectrometer, we do not obtain the characteristic spotted patterns of large grains, but the well-demarked spectrogram of smaller grains,[4] further modified by what must be a mixture of space lattices of various sizes. The patterns are identical with those which would be obtained from the fine mixed powders of a number of various alloys covering a broad range in a binary solid solution series. The first few diffraction lines are somewhat sharp, but become broader and more diffuse until at 30 or 40 deg. they are entirely lost. Such a cored alloy after prolonged heating near the melting point gives a normal pattern. Fig. 2 shows how the assortment of sizes of the same atomic arrangement produces, by superimposition, the diffuse, faint pattern. When the mechanism of coring is analyzed we come to the conclusion that the resultant alloys are actually an assortment of many crystals of varied spacings. The apparent grain boundaries inclose several orientations.

Let us consider a primary dendrite or crystallite just forming from the melt. It is a grain composed of two kinds of atoms. This grain can grow only so long as the added atoms can conform to the original lattice size or spacing within its elastic limit.[5] But its growth is inhibited. As shown in Fig. 3, the change in composition of subsequent layers forces a change in lattice size which in turn forces a new grain (and probably an entirely new orientation, for the zone of compromise would tend to produce rotation at some localities). It may be that a considerable part of the entire mass of a cored metal is of the imperfect crystallinity of grain boundaries. X-ray evidence on this point is further borne out by the fact that when badly cored metal is annealed and homogenized it frequently has a higher grain count than the apparent grain structure of the original cast material would indicate. This is very conclusive evidence, since grain growth occurs as they are permitted to attain equilibrium, except where allotropic changes interfere. The probable mechanism of this action is that two or more regions within the cored grain become grain-growth centers and are differently oriented even after diffusion has made them the same compositions.

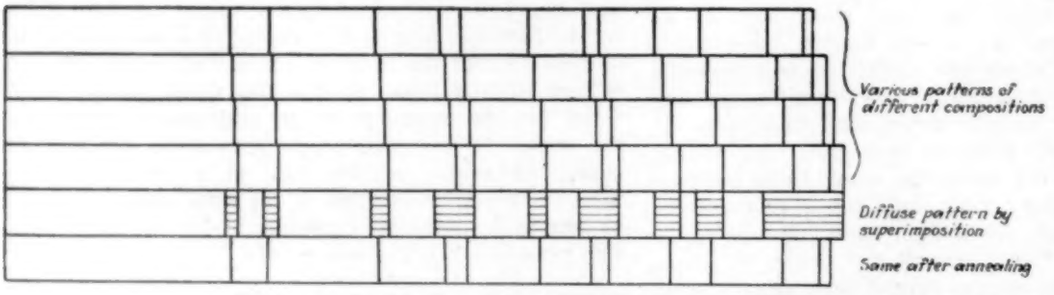


FIG. 2—DIFFUSE PATTERN OF CORED CRYSTALS DUPLICATED BY MIXTURES OF CRYSTALS OF SAME CRYSTALLINITY, BUT OF SLIGHTLY VARYING DIMENSIONS

Many of the alloys studied by the writer were made by mixing very fine powders and then heating to a temperature which would permit complete diffusion and homogenization entirely in the solid. It is possible in

[4] See "X-Ray Data on Martensite Formed Spontaneously From Austenite," by Edgar C. Bain, *Chem. & Met.*, March 22, 1922, vol. 26, p. 543.

[5] Elastic limit is low at high temperature.

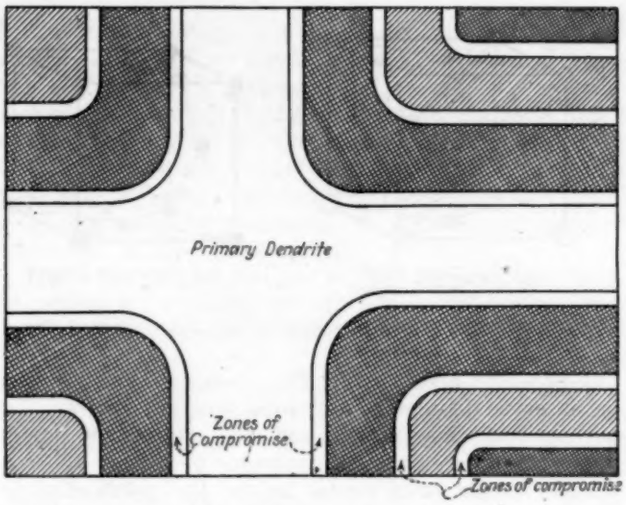


FIG. 3—THE PROBABLE STRUCTURE OF CORED METALS COMPOSED OF SHELLS OF DIFFERENT SIZED LATTICES

this manner to obtain perfectly uniform composition in less time than by melting the constituents and then destroying the cored structure resulting from the solidification. The aggregate paths of diffusion are shorter in fine powder than from zone to zone of the cored structure, for the latter is frequently coarse. Some mechanical deformation is most efficacious in removing cores. Fig. 4 shows the pattern of the mixed powders of gold and copper and after heating below the melting point.

The Ultimate Homogeneity in Solid Solutions

Obviously the most even and uniform distribution of two kinds of atoms in a space lattice is an arrangement of geometrical symmetry. For some atomic proportions this is quite simple. Let us consider an example. Fig. 5 is reproduced from the preceding contribution[5] which discussed the gold-copper series, and shows the arrangement for 3:1 and 1:3 atomic proportions in a face-centered cubic lattice. The 1:1 ratio in the body-centered arrangement or in the simple cubic pattern of rock salt (Fig. 1) is equally simple. For more complex ratios the geometrical arrangement is very much involved and may only be represented by groups of a certain ratio separated at frequent intervals by a leaner or richer zone.

The author has obtained conclusive evidence of the existence of such structures in a very few cases only. It comes about in this manner: The atoms of one metal alone may be considered as having their own space lattice. Thus, in a $25A:75B$ atomic proportion in the face-centered lattice shown in Fig. 5, the *A* atoms occupy a simple cubic lattice composed of the corners of the face-centered cubes. A little study will show that the *B* atoms occupy the corners of three equal systems of interpenetrating simple cubes.

Its pattern (Fig. 6) contains more lines than the face-centered lattice of both kinds of atoms. If these lines appear ever so weakly on a film, then there is ample proof of the arrangement. But to obtain such evidence there must be a difference in reflecting power in the atoms. Disparity in atomic weight is the usual cause. It should be remembered that it is the discontinuity in mass distribution which causes the lines on the patterns and excess mass is no more effective in causing interference minima (i.e., lines in the X-ray spectrogram) than the absence of matter.[6] In such simple geometric proportions as 3 to 1 or 1 to 1 we have the characteristic structure of compounds. Equal atomic proportions of molybdenum and tungsten (body-centered cubic system) show best the extra lines in the spectrogram which give us the clue to the atomic arrangement. Tungsten has almost twice the atomic weight of molybdenum and the spectral lines produced by the wide spaces between its planes alone cannot be "interfered out" by the weaker reflections of the molybdenum reflections 180 deg. out of phase. In the equal atomic ratio both molybdenum and tungsten atoms taken separately are in the simple cubic arrangement; the corners of one system are located in the center of the other.

There is another condition of the atoms in solid solutions offering a degree of homogeneity midway between this one of geometrical symmetry and the cored condition (which is similar to mixed powders of different composition). It is found in electroplate of two metals deposited out of solution simultaneously or in alloys which do not core and which have been cooled quickly from solidification. The space lattice is of uniform size and the atoms are of uniform concentration over a considerable area, but their arrangement is at random in the lattice. Neither kind of atoms considered alone could be said to possess a regular spacing. Prolonged heating near the melting point develops the final geometrical distribution.

Tammann has used a very expressive word for the rearrangement of the atoms which take place at high temperature. The word is "Platzwechsel"—place interchange. Its occurrence marks the temperature at which the mobility of the atom is such that it may migrate between and past its neighbors—one of these then taking its former position. In the new edition of his "Lehrbuch der Metallographie" a long chapter deals

[6] The X-ray method for crystalline analysis has been outlined by Bain in *Chem. & Met.*, Oct. 5, 1921, vol. 25, p. 657, and by Jeffries and Archer in *Chem. & Met.*, May 4, 1921, vol. 24, p. 771.

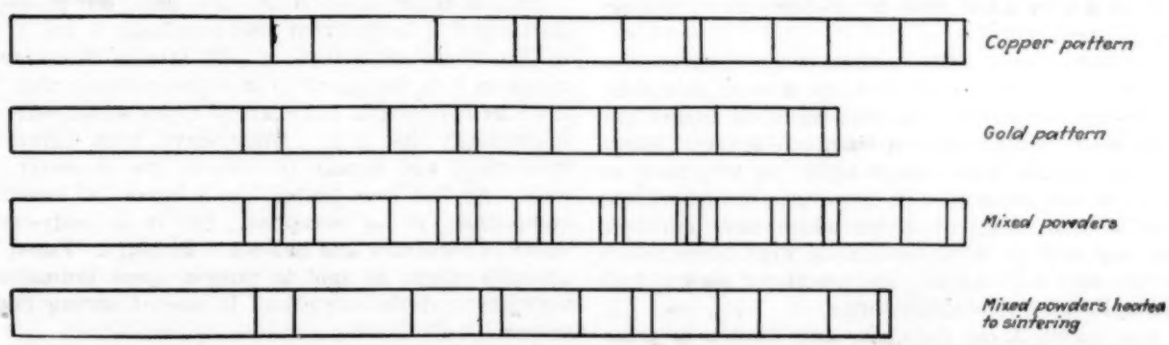


FIG. 4—PATTERN OF MIXED COPPER AND GOLD POWDERS, BEFORE AND AFTER SINTERING

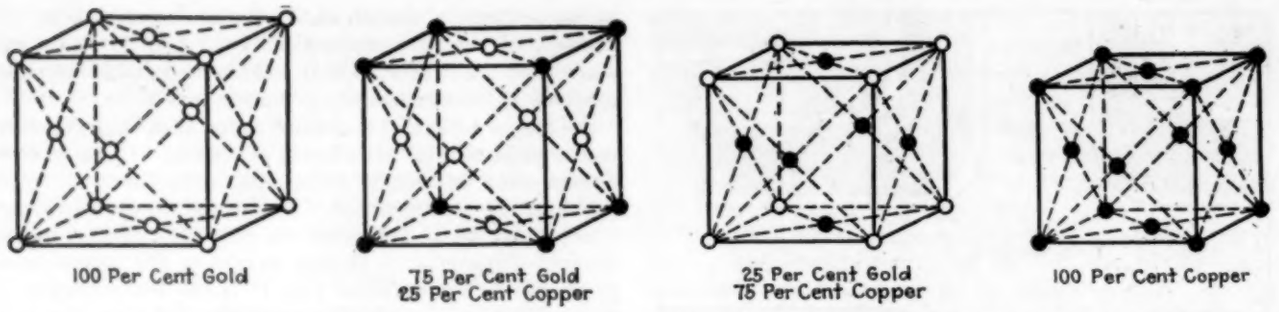


FIG. 5—ARRANGEMENT OF THE GOLD (LIGHT CIRCLES) ATOMS IN SPACE FOR CERTAIN GOLD-COPPER ALLOYS

with the change in chemical behavior observed when metals have been heated to bring about this final change in atomic distribution. In metals composed of two kinds of atoms which are not distributed with geometrical symmetry the change in single potential or chemical activity varies with change from one composition to another only as the theory of probability would indicate. The atoms of the nobler metal (i.e., with lower single potential) protect the other atoms to an extent dependent directly upon composition alone. But after "place interchange" has taken place, very abrupt changes in single potential with change in composition develop. These changes nearly always mark some simple atomic ratio. Thus: copper-gold alloys are rapidly attacked by nitric acid when there are fewer gold atoms than copper atoms in the alloy, but alloys richer in gold than 50 atomic per cent are attacked scarcely at all. The protective action begins abruptly at this definite composition. Therefore, there must be some subtle effect in the atomic distribution.

It appears that the situation is substantially one of availability of atoms for reaction. When the inactive atoms exceed a certain proportion and are arranged in the symmetrical positions for that particular proportion, there is no path for the reagent to penetrate the lattice and reach the active atoms. The protective action is then in effect. Below this proportion there are continuities of active atoms which can be reached successively after the surface lattice is caused to collapse. For a particular instance, consider the 75Au:25Cu lattice shown in Fig. 5. If that particular cube is located on the surface of the metal, it is seen that after the copper atoms on the corners of the top faces are removed, the next layer just below consists entirely of gold atoms.

Copper decomposes silver nitrate with the precipitation of metallic silver; gold does not possess this property. In the completely annealed series of copper and gold the alloys containing less than 1:7 Au:Cu decompose silver nitrate, while alloys richer in gold have no action with this reagent. If, however, the experiment is tried with a series of alloys which have not been heated long enough or at sufficiently high temperature to perfect this distribution, the reactivity simply falls off gradually with no definite limits.

As was stated, X-ray data give only limited information on the actual location of the separate atoms in well-annealed alloys, while this chemical behavior is to be observed in almost any solid solution series. The author had, however, found the significant supernumerary lines in the spectrograms of certain alloys of simple atomic proportions before the publication of these chemical and electrochemical data. The failure to find the extra spectrogram lines significant of geometrical arrangement of two kinds of atoms in other instances is easily explained. They are necessarily always extremely weak. Furthermore, an exact ratio (say 1:3 or 1:1) can never be obtained in any alloy which has to be weighed out and prepared. Compounds could be prepared in which considerable fragments might conceivably have an exact ratio of atoms, even though the number of atoms reached "astronomical" figures. But, in a single grain of an alloy there will likely be a small excess of one or the other atoms. Somewhere, then, in the grain (fortunately perhaps at or near the boundary where the crystallinity is less perfect) we shall have a discontinuity. This discontinuity, if involving an even number of atom rows, will not destroy the extra spectrogram lines, but if involving an odd number completely obliterates the lines. The result then becomes problematical indeed, and chance seems rarely to give us the evidence sought. At any rate the enlightening work of Tammann and his deductions from his observation—exactly in accord with what crystal analysis has shown in a small way—have given us an astounding conception of the forces which tend to produce the utmost homogeneity in metals by diffusion.

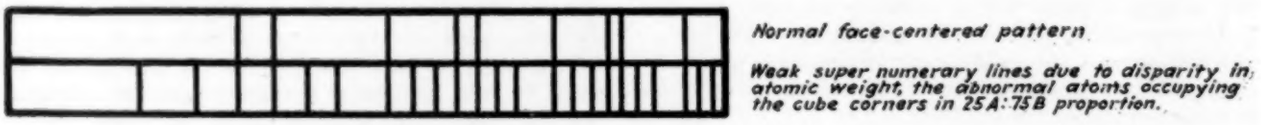

Normal face-centered pattern
Weak super numerary lines due to disparity in atomic weight, the abnormal atoms occupying the cube corners in 25A:75B proportion.

FIG. 6—FACE-CENTERED PATTERN WITH SUPERPOSED LINES FROM SIMPLE CUBE

Intermetallic Compounds

Intermetallic compounds are said to possess no ductility. It seems that this condition is not a result of the chemical nature of the atomic association so much as it is the result of the circumstance that intermetallic compounds have lattice types which offer little opportunity for slip.[7] They have been investigated somewhat, and appear to possess low symmetry as a rule. As has been stated,[3] beta brass (if based on a compound) is an exception, for it is body-centered cubic in structure and has some ductility. Fused silver chloride might be said to possess some indications of ductility and the compound is one of strong chemical

[7] It is perhaps unnecessary to remark that when ductile metals are overstrained, they deform by intercrystalline slip.

nature in comparison to many of the intermetallic compounds. The silver atoms alone are arranged in a face-centered cubic structure, as are also the chlorine atoms alone, but both together form a simple cubic lattice. Fig. 1 shows the exactly similar lattice of NaCl. It is obvious that the like atoms, taken by themselves, build up face-centered lattices, interpenetrating. The compound Cu_3Sn is close packed hexagonal in type (like zinc).

The outstanding feature of the intermetallic compounds is their ability to retain the lattice form over a considerable change in constitution. We can scarcely conceive of any portion of sodium chloride or ferrous sulphide or calcium oxide as having any variation in composition from the "atom for atom" ratio, even though the compound is formed where one constituent is in great excess. On the other hand, we find sometimes that the crystalline structure of an intermetallic compound is formed with a composition which depends on the composition of the melt from which it is developed. In other words, in a compound which would normally contain say three atoms of *A* with one of *B* (A_3B), there is nothing to prevent the substitution of a few *B* atoms in the *A* lattice points. This ability to retain the crystalline phase intact despite a change in constitution probably is a result of the same fundamental structure within the atom which gives many metals their outstanding property of ductibility or malleability by slip-plane formation.

Lines of Attack on Future Problems

Of the array of interesting problems which may find a solution in the study of crystal structure there is one which is worthy of considerable investigation. It is the author's belief that in some cases a solid solution may form by the annexation of small atoms to large ones while these large atoms retain their usual lattice position. Thus, when carbon dissolves in gamma iron it is conceivable that the carbon atoms might associate with certain iron atoms—not displacing them, but simply "adding on." There is evidence on both sides of this question, and the facts will surely be discovered by X-ray examination. Experiments are now well under way in the author's laboratory to determine the point.

And again, austenite formed by the solution of carbon in gamma iron may be rapidly quenched to inhibit the carbide formation and grain growth but allow the allotropic change. The question then arises, "What is the relation between the carbon atom and the new alpha iron lattice comprising the tiny ferrite grains forming martensite?" It has been styled a solution of carbon in alpha iron—but the word "solution" is not well chosen, for there is only mechanical stability in martensite. The carbon is atomically dispersed, probably, in freshly quenched martensite, but at best it is only a "pseudo solid solution."

Such problems at present have little hope for solution except by some very subtle sort of examination involving the atoms themselves, such as by X-ray spectrometry.

Acknowledgments

The author desires gratefully to acknowledge the assistance of two of his co-workers in the investigation of the numerous alloys. To W. P. Sykes thanks are to be given for the preparation of a number of alloys from mixed powders and to A. B. Gladding thanks are due for the careful computation of several space lattices.

Increase in Science Department Students at Princeton

According to figures compiled by the registration department, Princeton University, Princeton, N. J., there has been a pronounced decline of interest in the classics in the last year, and a corresponding increase of interest in science. This change is illustrated by the number of students taking the courses in the two departments in 1921 and 1922. In the first-noted year there were 730 men in the university taking either Latin or Greek; at the present time this has decreased to 659; the increase of students in modern languages this year was from 1,249 to 1,459. In 1921 the number of men taking either chemistry, biology, physics or geology was 1,712, while at the present time the science department has 1,842 students. A library of industrial relations is being established at the institution under the direction of Prof. Robert F. Foerster, made possible through a donation of $60,000 by John D. Rockefeller, Jr., for this purpose.

Electron Emission From Heated Metals*

When metals are heated in high vacuum, electrons, or atoms of negative electricity, evaporate from their surfaces. If there is another electrode in the evacuated space which is given a positive charge, the electrons drift over to this electrode (anode) so that a current flows between the two electrodes. Dushman has recently derived an equation which should supersede the well-known Richardson equation, giving the relation between the electron current and the temperature of the cathode. The advantage of this new equation is that there is only one constant which we need to know for each different cathode material, instead of two constants which were necessary for the Richardson equation.

The electron emissions from a large number of different materials have recently been measured. The thoriated tungsten cathode gives a current at a temperature of 1,500 deg. C. absolute, which is about 130,000 times greater than that from ordinary tungsten. Measurements have also been made of cathode materials that have even much greater emissions.

In order to get all the current that a cathode is capable of giving, it is necessary to apply to the anode a high enough voltage to overcome what is known as the space charge effect. By putting in gases positive ions are formed in the space between the electrodes, and these neutralize the negative space charge and allow the current from the cathode to pass across the space with much lower anode-voltages. In other words, the effect of gases is to increase the current-carrying capacity of the two. Such an effect is used in the Tungar rectifier. Care must be taken what gas is used for the purpose, for many gases have the effect of poisoning the cathode, and cutting down its emission to a small value.

If very high voltages are used on the anode, so as to produce intense electric fields, it is possible to pull electrons out of the cathode. In fact, it is possible to pull electrons even out of cold cathodes—that is, cathodes at ordinary temperatures. The currents obtained this way from the cathode come from very minute areas, but in these areas the current density amounts to more than one hundred million amperes per square inch.

*Abstracted from a lecture by Dr. Irving Langmuir, Pittsburgh, Pa., Nov. 29, 1922.

Menace of Loosely Drawn Contracts

Much Litigation Caused by Inadequate Expression of Intention of the Parties—Examples of Court Decisions Under Varying Conditions

By Wellington Gustin
Member of the Chicago Bar

WHEN does a contract provide for the sale to fill a buyer's requirements over a given period and when does it provide for the sale of a seller's output? These are questions of real seriousness. When two contracting parties close a deal for an output of one's plant or factory over a given period, or for one's requirements for his plant, factory or business over a period they should take special precaution to see that the instrument called a contract embodying their agreement expresses their intention. For the intention of parties to a contract determines the construction a court will ultimately place upon it, and this intention will be gathered from the instrument itself where possible and ordinarily the parties will not be permitted to explain this intention. If the contract as written purports to be a complete contract, their outside testimony or evidence will not be heard to explain what this intention was and what the contract means. A reason for this rule is that the parties themselves dispute and their written expression must be looked to. Another rule is that the language used or employed by one will be construed most strongly against the user.

Intention Must Be Clearly Written

In the ordinary case of dispute in these matters there is an agreement in the intention of the parties to the contract well known at the time of its execution. The error made by the parties is that their intention is not certainly and completely expressed in the writing to which they resort in order to embody their agreement. Herein is the mistake that results in most of the litigation over contracts for "outputs" and "seasonal requirements" and the like. Such contracts are of such supreme importance to a plant or industry that one should ordinarily be surprised to find difficulties and misunderstandings as to the meanings of the agreements with a resultant failure to keep engagements.

But one may wonder if a great portion of such disagreements over one's undertakings is not really an attempt to avoid a bad bargain. In some cases arising since the war it is certain that parties did enter into contracts which proved exceedingly fortunate for some and exceedingly unfortunate for the others. Some used maximum requirements under contracts where otherwise they would have used minimum requirements; others were fortunate in having no limit attached to their requirements. Similar conditions existed on all sides. Most of the parties adjusted inequalities. Some openly violated their agreements to furnish at specified prices, and sold to the highest bidders. The extraordinary times were responsible for extraordinary measures being taken between parties.

Contract Should Embody Full Intention

Honesty in contract obligations does not concern us here, but as a matter of precaution and information, the many cases here cited should warn parties contracting in the future to embody their full intention and agreement in language that cannot be misinterpreted and misconstrued by others when nothing but the cold type or writing can be resorted to, as when it is made the basis for a court action or defense. And where contract obligations are sought to be avoided, whether honesty and honor in business undertakings enter in or not, the party who finds that the language of the contract expresses with certainty what he intended it should will be fortunate indeed, while if he has ignorantly or negligently and carelessly used language that does not express his intention he may be surprised to wake up in the hour of greatest need for certainty in his contract to find that he has a contract which cannot be enforced, or otherwise, with actual or contemplated profits wiped out.

In a case arising in 1900 in Illinois the court says: "The contract in question is for appellee's "requirements" in stove bolts from Dec. 14, 1898, to Jan. 1, 1901, and this means such amount of stove bolts as appellee should need in the regular course of its business and not what appellee might choose to require from appellant." Russell, Burdsall & Ward vs. Excelsior Stove & Manufacturing Co., 120 Ill., App. 23.

In this case the price of the bolts soared and the claimant's requirements not being satisfied by the seller, the buyer went out into the open market and bought the goods and the additional cost above the contract price to the buyer was charged to the seller.

Case Involving Entire Output

In another case on "output" the Supreme Court of Illinois said that a contract whereby a cement company agrees to sell, and a sand company agrees to buy, the entire output of the cement company's plant for a year at a certain price per barrel is compiled with if all cement manufactured at the plant is shipped to the buyer.

And if the manufacturer has shipped to the buyer all the cement produced at the plant in question, the buyer has no right to refuse payment under the contract upon the ground that the manufacturer's delay in filling orders has caused a loss to the buyer, and upon the buyer's refusal to make payment the manufacturer may treat the contract as terminated, discontinue shipments and sue for the balance due on goods already delivered. Garden City Sand Co. vs. Wellington R. Burt, 237 Ill., 473.

In the above case the test of quality for the cement to be manufactured was the standard of the specifications of the American Society of Engineers. The court here held that if the buyer contended the quality of the product delivered was not up to the standard of the warranty the burden of proof rested upon the buyer to show that fact.

The buyer contended that it appeared from the contract and from extraneous facts and circumstances in evidence that the parties intended that the plant should be operated to its full capacity, and that the buyer should receive during the year what cement could reasonably be produced by the plant when run at its full capacity. The court said the contract did not so state and the court could not import into the contract a provision which the parties have omitted therefrom. "Ordinarily," it says. "a reference to what are called surrounding circumstances is allowed for the purpose of ascertaining the subject matter of a contract or for an explanation of the terms used—not for the purpose of adding a new and distinct understanding." And in another case, Knox vs. Lee, 12 Wall, 475, the court there said: "There is a well-recognized distinction be-

tween the expectation of the parties to a contract and the duty imposed by it. . . . Were it not so, the expectation of results would be always equivalent to a binding engagement that they should follow."

Questions of price and quantity are interesting in a case recently decided by the U. S. Circuit Court of Appeals and affirmed by the denial of a certiorari by the U. S. Supreme Court, 42 Sup. Ct. 586. Plaintiffs, Taylor, Lowenstein & Co., brought an action at law against the Louisville Soap Co. to recover damages for a breach of contract for the purchase of rosin, in which defendant filed a cross-petition to recover overpayments made by it.

The contract provided for the sale by plaintiffs to the soap company of a quantity of standard quality grades G, H and I rosin. The defendant's cross-petition was based upon its construction of this contract in reference to price, and sought to recover payments in excess of the contract price. Two questions were presented to the court: first, as to the quantity covered by the contract, second, as to the price to be paid.

In reference to quantity the contract provided: "Louisville Soap Co.'s requirements from April 1, 1918, to March 31, 1919, 20,000 round barrels minimum, 40,000 round barrels maximum. Should buyer's requirements be for more than the maximum amount stipulated herein, orders for such excess are to be submitted to seller. If seller cannot supply, buyer will be privileged to buy such excess elsewhere."

Under this contract the soap company ordered and received, within the year, 12,989 round barrels of rosin, for which it paid in full, and which amount constituted its entire requirements. Plaintiffs brought this action to recover damages for the failure of the soap company to take 7,011 round barrels, the difference between the amount they did actually order, receive and pay for, and the minimum amount of 20,000 round barrels specified in the contract.

Dispute as to "Requirement"

The soap company contended that this was a "requirement" contract and that the provision "20,000 round barrels minimum, 40,000 round barrels maximum" is a mere estimate of the amount of rosin it would require for the year, and that therefore it was not obliged to take any rosin in excess of its actual requirements.

In reference to the second question as to price, the contract reads: "to be 50c. per 280 lb. over the official closing Savannah, Ga., market on date order is received at Mobile, Ala. In the event of two closing prices, the average is to apply."

The soap company contended that this provision in which the price was to be determined by the official closing price of a board of trade, instead of a fixed, definite and certain contract price to be paid, regardless of the market price, was further evidence of the intentions of the parties that the actual requirements of the soap company was the dominant provision of the contract as to quantity.

Adversely, Taylor, Lowenstein & Co. claimed that the soap company was required by this contract to accept and pay for this minimum amount of 20,000 round barrels regardless of its requirements, and as many more barrels as they required for their factory; that the provision in regard to requirements applied only to the difference between the minimum 20,000 bbl. and the maximum 40,000 bbl., which maximum quantity the Taylor company obligated itself to furnish the soap company if the requirements would amount to so many barrels, and if the soap company's requirements exceeded the maximum amount, then it had the right to elect whether or not it would accept or reject any orders in excess thereof.

Specifications as to Maximum and Minimum Held to Be Dominant Measure of Quantity

The court said there appeared to be an irreconcilable conflict between the courts as cited by the opposing counsel in support of their respective claims. But the various cases show that each was decided in reference to the particular contract involved, or upon a consideration of the "obviously dominant measure of quantity" in each contract. In the present case the contract does not suggest that the minimum and maximum amounts named are merely estimates. On the contrary, from the substantial difference between these figures it appears that the parties intended that the requirements should control between these two amounts, but should be neither less than the minimum nor more than the maximum. And it is specifically provided that if the requirements should exceed the maximum quantity named, the seller should not be obligated to furnish the same, except at its option. This maximum is specifically set up the contract as the limit of the seller's liability to furnish, said the court. Therefore it is a definite controlling quantity and not a mere estimate. And it would seem absurd to say that the parties intended that the maximum should be the dominant measure of quantity as to the seller's obligation to furnish, but that the minimum should not be the dominant measure of quantity as to the buyer's obligation to take.

Now in the case of Taylor, Lowenstein & Co. vs. Louisville Soap Co., above mentioned, it was insisted upon the part of the soap company that if the minimum and maximum named in the contract should be held to be the measure of quantity to be furnished thereunder, it would take all the meaning out of the further provision of the contract in reference to the company's "requirements." The court says that, on the contrary, such a construction would give full force and effect to both these provisions in relation to quantity, for there is a large scope for the operation of the provision as to requirements between 20,000 and 40,000 round barrels. While on the other hand, if the company's requirements were to be construed as the absolute measure of quantity, then the provision as to minimum and maximum quantity would be meaningless. Hence the court concluded that this contract required the buyer to accept and pay for the minimum of 20,000 round barrels of rosin, and it likewise required the manufacturer to furnish this amount and any amount in excess thereof, up to the maximum of 40,000 bbl., limited in that respect only to the buyer's needs.

Price Clause Also Uncertain

In this instant case another interesting point of uncertainty in the contract is shown. This relates to the price to be paid from time to time for the product. Under the contract for rosin it was to be paid for at a stated price above the official closing Savannah, Ga., market, which was intended to be the official closing price posted by the Savannah Board of Trade. It appeared that under the rules of that Board of Trade the official price could be determined only from actual transactions between factors and buyers, and that dur-

ing the last 2 months of the contract period there were no sales on which the closing price could be based. On this point the court held that there was no closing price within the meaning of the contract, although during that period the committee did post the closing price as determined by the last sale.

And where the price of goods sold was to be determined by the official closing price of a board of trade on the day the order was received, and during the last part of the contract period there was no closing price in that market so that the contract price could not be determined, both parties were relieved of their obligations under the contract. (Here was uncertainty again in the contract.)

But where the buyer ordered and received some of the goods after there was no closing price, though the last price determined by actual sales was daily posted as the closing price, and the seller made no misrepresentations which would prevent the buyer from ascertaining the true facts in regard to the posted closing price, the payment for the goods in accordance with the posted price was an acceptance of such price and the buyer thereafter could not recover such or excess payments.

Other Typical Cases

For the benefit of those who may contract "outputs" or "requirements" the following cases are cited briefly:

The Louisville Soap case is found to be identical in language to the contract involved in another case, the Diamond Alkali Co. against Aetna Explosives Co., 107 Atlantic Reports 711. Here the contract provides, in reference to the quantity, "Buyer's entire requirements during 1916; minimum quantity 180 tons per month and maximum 250 tons monthly." In this case the court held:

"The minimum and maximum quantities fixed in the contract were not merely probable estimates of the quantities which the appellant was to take . . . but were definitely fixed quantities which the appellant could demand and the appellee was required to deliver."

In the action brought by the Staver Carriage Co. against the Park Steel Co., 104 Federal Reports 200, on contract, the instrument provided as to quantity: "All the tire steel, of good and suitable quality, which will be used in buyer's works prior to Sept. 1, 1899, not to exceed 14,000 sets, nor to be less than 10,000 sets."

Here the court held that this was a valid and binding contract within the different amounts specified; that the seller was obligated to furnish at least the 10,000 sets and as many more up to 14,000 sets as was actually needed for use in the buyer's work prior to Sept. 1, 1899, citing National Co. vs. Keystone Manufacturing Co., 110 Ill., 427, also Stover vs. Park Steel.

In another suit, Budge vs. United Smelting Co., 104 Fed., 498, the contract required the seller to furnish "all the mining timbers required and used at buyer's mine, about 600 pieces of the larger dimensions and about 15,000 pieces of the smaller dimensions." Here the court held that this was a distinct promise to receive and pay for about 600 pieces of one kind of timber and 15,000 of another.

In still another case, Highlands Chemical Co. vs. Mathews, the contract required the seller to deliver to the buyer, if required by him, 10,000 carboys of oil of vitriol, the defendant to take at least 7,000 carboys during the same time. In this case it was held that the defendant was bound to take the minimum amount, whether he needed it or desired it for the purpose of his business or not; and the correlative obligation rested upon the seller to deliver any amount within the maximum fixed by the contract if the buyer's needs required the same. Here the minimum of 7,000 carboys and the maximum of 10,000 carboys are obviously the "dominant measure" of quantity.

In a U. S. Supreme Court case, Smoot vs. United States, 35 Supreme Court 540, the contract provided for 140,200 cu.yd., more or less, of filter sand, for a specific construction of twenty-nine filter beds. It appeared from the contract itself that the quantity mentioned therein was approximate only. It was insisted, however, by the United States that a letter written by the government engineer, subsequent to the contract, specifically fixed the quantity at 151,000 cu.yd. This, however, did not allow for shrinkage, and the actual requirements of the government were 179,231 cu.yd. The Supreme Court held that a letter from the engineer in charge of the construction, to a contractor, who had entered into a written contract with the United States to furnish material at a specified price, could not modify the original contract or constitute a new one; that under the terms of the original contract the amount named therein was clearly an approximate amount only; and that the needs of the government for this particular construction was the obviously dominant measure of the quantity to be furnished.

Points on Proper Construction of Contracts

Thus it will be seen, from these many cases cited, that much litigation occurs from lack of attention to the provisions of so important a class of contracts involving whole outputs of plants and all requirements for plants and industries. As was said in one of the cases: "Where the parties have entered into written engagements, with express stipulations, it is manifestly not desirable to extend them by implication. The presumption is that having expressed some, they have expressed all the conditions by which they intend to be bound under the instrument . . . and it is one thing for the court to effectuate the intention of the parties to the extent to which they may have even imperfectly expressed themselves, and another to add to the instrument all such convenants as upon full consideration the court may deem fitting for completing the intention of the parties, but which they, either purposely or unintentionally, have omitted." The former construes that which is written, "the latter adds to the obligation by which the parties have bound themselves, and is, of course, quite unauthorized, as well as liable to great practical injustice in the application."

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Vapor Recompression System for Evaporators—II

Regenerative Evaporation Is Critically Discussed, With Particular Reference to the General Theory of Design and Construction—Comparison of Operating Economies With Single and Multiple Effect Evaporators—Bibliography of Patents and Literature References*

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General Theory

THERE have been a number of discussions of the general theory of vapor recompression. Of these the papers by Claassen (9, 15),† Flugel (18), Holmes (20), and Wirth (46) are the most important.[3]

NOZZLES

The nozzle systems are perhaps the easiest to discuss qualitatively. From the curves of Figs. 9, 10 and 11‡, any case that is apt to arise may be calculated. It is evident that for high efficiency (in the sense of vapor compressed per pound high-pressure steam used) it is necessary to work with a small temperature drop and very high-pressure steam. From Fig. 9 it will be seen that to get double effect efficiency (1 lb. vapor entrained per pound high-pressure steam) the total temperature drop may not be over 18 deg. F. for 100 lb. steam, 22 deg. F. for 150 lb. steam, or 22.5 deg. F. for 175 lb. steam. Ordinarily evaporators are designed to operate with 5 to 15 lb. steam. If a single effect evaporator with a nozzle compressor be compared with a double working between 10 lb. and 26 in. vacuum, we find that the double has a total available temperature drop of 100 deg. F. against, say, 20 deg. for the other. Hence, on material of no elevation in boiling point, the double would have five times the capacity of the single, twice the heating surface, and would require the same amount of steam, condensing water and accessories.

On the other hand, if we assume that the plant has exhaust steam to spare, then the comparison is still more strongly in favor of the double. If a nozzle is used, either the power units must be run condensing, or exhaust must be wasted. If an ordinary double is used, it saves either all the high-pressure steam used in the nozzle (if exhaust was available which would otherwise be wasted) or it saves all the condensing equipment and condensing water otherwise needed for the prime movers.

The best use for the nozzle is the plant where all exhaust from prime movers is used in the evaporators and in addition make-up has to be supplied as live steam. A nozzle may be substituted for the usual reducing valve on the make-up steam line; provided, of course, that the evaporator in question is a multiple effect with a small enough temperature drop in the first effect to make the nozzle efficiency appreciable. Here again attention must be paid to the rapidly decreasing efficiency of the nozzle as the steam pressure drops; because if the amount of make-up needed is variable, the nozzle will give useful results only when the throttle valve is wide open. Under conditions demanding less than the maximum amount of make-up steam, its capacity will be negligible. This has been discussed by Claassen (9), who suggests several small nozzles in parallel to be cut in or out one at a time as the demand for make-up varies, but each to be either completely closed or wide open, never throttled.

MECHANICAL COMPRESSORS

Thermal Efficiency of Evaporators.—If the conditions are properly chosen and certain important considerations omitted, it is possible to show that vapor recompression systems are very desirable. For comparative purposes, let us assume that an ordinary evaporator uses steam at 5 lb. gage, and returns the condensate to the boilers at 180 deg. F. Then to regenerate 1 lb. of steam takes (1,155 — 180) or 975 B.t.u. Considering losses by radiation, heating feed, withdrawal of hot thick liquor, etc., let us assume that 1 lb. steam will evaporate 0.85 lb. water per effect. Then, for purposes of comparison, we will have as the performance of an ordinary evaporator:

Effects	B.t.u. Supplied in Boiler Per Lb. Evaporated
1	1,150
2	563
3	382
4	286

Let us also assume that the power used to drive the turbo-blower is generated in steam prime movers whose water rate is 20 lb. per kilowatt-hour. This rate, however, applies to steam of 160 lb. gage, which requires (1,195 — 100) or 1,095 B.t.u. to regenerate a pound. This assumes condensate returned to the boilers at 100 deg. F. because vapor recompression evaporators usually use a heat interchanger which cools the condensate and heats the feed. Ombeck's tests show 75 to 165 lb. evaporated per kilowatt-hour, or 3.5 to 8.25 lb. per pound boiler steam. This gives from 312 to 133 B.t.u. supplied in boilers per pound water evaporated. Wirth's data show 25 to 55 lb. evaporated per kilowatt-hour; or 875 to 400 B.t.u. per pound evaporated. Hence Ombeck's best tests correspond to 8.5 effect operation, and his poorest to 3.5 effect. Wirth's range from 1.5 effect to double effect efficiency. Such tests as Ombeck's and such reasoning as the first paragraphs of Article I are the basis for the claims so often made of "multiple effect efficiency in a single body."

It should be pointed out again that Ombeck's tests were run on that combination of conditions which is the most favorable to recompression. Wirth's data represent much more general cases. The efficiencies which have been calculated by advocates of thermocompression have not been confirmed by submitting operating data.

CAPACITY

The principal factors omitted by partisans of the thermocompressor are power generation and capacity of the evaporators. It is obvious that the turbo-blower must work on a small temperature drop. Thus Ombeck works with from 6 to 14 deg. F. Wirth gives no data but his evaporation per square foot per hour indicates

*Read before the American Institute of Chemical Engineers at Baltimore, Dec. 9, 1921. Part I of this article appeared in *Chem. & Met.*, vol. 28, No. 1, Jan. 3, 1923, p. 26.

†Numbers in parentheses refer to bibliography at end of this article. Numbers below 100 are articles and above 100 are patents.

‡See figures published in Part I.

[3]See also 1, 32, 33, 47.

a similar or larger temperature drop. Ombeck evaporates 1.7 lb. per square foot with 6.5 deg. drop and 3.9 lb. with 14 deg. Hence, assuming similar coefficients, Wirth must be working with 10 to 60 deg. drop. This explains Wirth's lower efficiency rating. Most discussions have been based on a drop of 18 deg. F.; and Soderlund and Boberg specify 5 deg. F.

Now ordinary evaporators usually run on about 100 deg. F. temperature drop. Hence if the discussion has to do with an ordinary evaporator in single effect, the thermocompressor evaporator must have from two to ten times the heating surface to do the same work if the coefficients are the same. The lower figure for heating surface corresponds to so large a temperature drop that it would involve less than double effect efficiency. In an ordinary single effect evaporator, the boiling point will be lowered corresponding to the vacuum. Hence there will be difficulty from increased viscosity, hydrostatic head, etc. The thermocompressor, working at atmospheric pressure, will have slightly better conditions so far as these factors are concerned. Ombeck's coefficients, the only ones so far reported, are no larger than are regularly obtained under good conditions in ordinary evaporators.

A double effect will have an average temperature drop of 50 deg. per effect. Hence if a thermocompressor could work with double effect efficiency on a 50 deg. drop with double the ordinary coefficients of heat transmission, it would do in one body all that an ordinary evaporator will do in two, both from the standpoint of thermal efficiency and of capacity. It would then remain to balance the cost of turbo-blower and driving unit on the one hand against the extra body of the evaporator and its condenser on the other. Similarly, the two methods are equal (except for difference in cost between the blower and the two bodies) if a thermocompressor could give triple effect efficiency on a 30 deg. drop with three times the ordinary coefficients. Wirth does not get triple effect efficiency in any case, and Ombeck gets it only on a 14 deg. drop. There is no evidence to support the assumption of higher coefficients in evaporators using recompression. Hence it may be definitely stated that a thermocompressor will call for much more expensive equipment than an ordinary evaporator.

Superheat.—Another factor which may affect the capacity of vapor recompression evaporators is superheat in the compressed steam. Pure adiabatic compression will necessarily result in some superheat. Turbo-blowers have a mechanical efficiency of 60 to 70 per cent according to size. This loss of 30 to 40 per cent of the power input should reappear as additional superheat in the compressed steam. Ombeck's blower had efficiencies from 45 to 65 per cent, but his results show superheat only a little greater than called for by adiabatic compression. This was probably due either to long pipe lines between blower and evaporator, with the measurements made near the evaporator; or to faulty measurements of the temperature of the steam. This is a very difficult determination to make with even moderate accuracy. The superheat on large working temperature drops may be over 100 deg. F.

The effect of superheat has never been settled because, even with large amounts of superheat, the heat present as superheat is small, and is transmitted in the first fraction of the heating surface. No tests have ever been made where an appreciable part of the heat available for evaporation was superheat.

It is generally supposed that the presence of superheat considerably lowers coefficients of heat transmission from steam to metal. This comes from the well-known fact that permanent gases give up their heat very slowly. The actual data available are entirely insignificant, and it is still an open question as to what effect superheat may have. If it has any effect, then evaporators using turbo-blowers must suffer greatly and cannot show normal coefficients of heat transmission.

In general, then, an evaporator using thermocompression will call for a larger investment in apparatus than an ordinary evaporator; and where it does not, it shows no special saving in steam.

Power Generation

Such a discussion as the above tells only half the story. No problem in evaporation should ever be discussed without including the question of power generation in the same plant. In the case above of the ordinary evaporators run on 5 lb. steam, the steam would in practice be exhausted from prime movers. Obviously, if the power demands of the plant are provided for and all exhaust used in existing equipment, adding a new evaporator would call for the generation of more steam and the comparison just made would need no modification. If exhaust steam were going to waste, the turbo-generator could not be considered, because the ordinary evaporator would run on exhaust, making no additional demands on the boilers. The thermocompressor would have to have high-pressure steam direct from the boilers.

Single Effect Operation

Consider a new department where both power and evaporation are to be provided and plans may be made for co-ordinating the two. The total amount of evaporation to be accomplished will call for a single effect only. In one case let us assume steam raised in the boilers at 160 lb. gage, expanded to 5 lb. in turbines, and sent to evaporators. The turbines generate power which can be used in the plant or sold. In the other case, let us assume 160 lb. steam raised in the boilers, part being used in condensing turbines to generate power equivalent to the power in the first case, and part used to operate evaporators. Let us base the comparison on 1 kw.-hr. under the first case, and consider that there is enough evaporation to be done to use all the exhaust there provided. The assumption made previously that 1 lb. steam to the first effect will evaporate 0.85 lb. of water per effect will still be made. The various possibilities are as follows:

Case *A*—1 kw. of power used, generated in non-condensing prime movers, exhaust to single effect evaporator operating on 100 deg. temperature drop.

Case *B*—1 kw. used, generated in condensing prime movers, additional steam used for single effect evaporator.

(1) Steam raised at high pressure, expanded through reducing valve for an evaporator which is same as in Case *A*.

(2) Same as (1), but expanded through a nozzle which compresses 1.2 lb. vapor per pound steam through an 18 deg. temperature drop.

(3) The additional steam generates additional power in condensing prime movers, this power being used to drive a turbo-blower.

(*a*) Blower gives 70 to 80 lb. evaporation per kilowatt-hour on a 14 deg. temperature drop (Ombeck).

(*b*) Blower gives 40 lb. evaporation per kilowatt-hour on a 25 deg. temperature drop (Wirth).

A comparison based on 40 lb. boiler steam raised, would give:

	Case *A*	Case *B* (1)	Case *B* (2)	Case *B* (3*a*)	Case *B* (3*b*)
High-pressure steam to be raised	40 lb.	20 lb. for power 20 lb. for evaporator	20 lb. for power 20 lb. for nozzle	20 lb. for power 20 lb. for blower turbine	20 lb. for power 20 lb. for blower turbine
Power units.....	1 kw. non-condensing turbo-generator	1 kw. condensing turbo-generator	1 kw. condensing turbo-generator	2 kw. condensing turbo-generator, motor-driven blower	2 kw. condensing turbo-generator, motor-driven blower
5-lb. steam available for evaporators:					
Exhaust or expanded.....	40 lb.	20 lb.	20 lb.	None	None
Compressed.....	None	None	24 lb.	70-80 lb.	40 lb.
Total.....	40 lb.	20 lb.	44 lb.	70-80 lb.	40 lb.
Total evaporation..	34 lb.	17 lb.	37 lb.	60-68 lb.	34 lb.

A comparison based on 34 lb. of evaporation in all cases would give:

	Case *A*	Case *B* (1)	Case *B* (2)	Case *B* (3*a*)	Case *B* (3*b*)
Total steam to be raised	40 lb.	60 lb.	36 lb.	30 lb.	40 lb.
Water for condensers:					
Power condensers....	None	500 lb.	500 lb.	750 lb.	1,000 lb.
Evaporator.....	850 lb.	850 lb.	850 lb.	None	None
Total.....	850 lb.	1,350 lb.	1,350 lb.	750 lb.	1,000 lb.
Heating surface of evaporators.....	x sq.ft.	x sq.ft.	3.7x sq.ft.	4.8x sq.ft.	2.7x sq.ft.

In order to make a clearer picture, consider a case in which the total evaporation to be accomplished is 1,000 gal. per hour. On a conservative rating the evaporator in Case *A* should have about 350 sq.ft. The steam consumed in Case *A* will be 9,800 lb. per hour (0.85 lb. evaporation per lb. steam), which corresponds to about 250 kw. power for the plant. Based on the preceding table we shall have:

	Case *A*	Case *B* (1)	Case *B* (2)	Case *B* (3*a*)	Case *B* (3*b*)
Total steam needed per hour.....	9,800 lb.	14,700 lb.	8,800 lb.	7,400 lb.	9,800 lb.
Total water needed per hour.....	25,000 gal.	40,000 gal.	40,000 gal.	22,000 gal.	29,000 gal.
Heating surface.....	350 sq.ft.	350 sq.ft.	1,300 sq.ft.	1,700 sq.ft.	950 sq.ft.

Too many factors come in to make a hard and fast comparison of costs. The following table shows, very roughly, however, what may be expected in an average case. Overhead (interest, depreciation, repairs, etc.) is estimated at 20 per cent per year (300 working days). Labor is considered equal in all cases, and hence omitted. Steam is not brought into the cost, as its cost is too uncertain; but data for steam consumption have been given and steam cost may be inserted as desired. Water is taken at 5c. per 1,000 gal.

	Case *A*	Case *B* (1)	Case *B* (2)	Case *B* (3*a*)	Case *B* (3*b*)
First cost:					
Evaporator and accessories.....	$900	$900	$3,300	$4,300	$2,400
Power unit and accessories.....	8,500	9,500	8,500	19,000	19,000
Blower or nozzle.....	.....	.....	500	14,000	16,000
Total.....	$9,400	$10,400	$12,300	$37,300	$37,400
Cost per day:					
Overhead.....	$6.30	$6.90	$8.20	$24.90	$24.90
Water.....	30.00	48.00	48.00	26.40	34.80
	$36.30	$54.90	$56.20	$51.30	$59.70
Excess cost over Case *A* exclusive of steam...	.....	18.60	19.90	15.00	23.40
Steam saved over Case *A*, tons per day.....	.....	(Uses more than *A*)	12	29	0

Case *B*(3*a*) is the ideal case, and will seldom occur; but if the conditions here represented exist, and if steam costs over 50c. per ton, this calculation shows a saving. Actual operating conditions will come much nearer *B*(3*b*), and here there is no saving in steam and an increased cost of $23.40 per day. In other words, in the case apt to occur in practice, the turbo-blower saves nothing in steam and may be much more expensive to operate than an ordinary evaporator. This reasoning leaves out of account the more expensive labor to operate the turbo-blower evaporators, differences in piping and distribution, etc. If the solution has an elevation of boiling point, the case against the thermo-compressor is still worse.

Multiple Effect Operation

Suppose the plant could not use 250 kw. of power, but that 80 kw. could be disposed of. This power, generated in a non-condensing prime mover, would give about 3,300 lb. exhaust per hour for Case *A*. This is about a third of that available in the previous illustration; but our 1,000 gal. of evaporation per hour could be now accomplished with this steam in triple effect. This case is rather abnormal, as the sizes of all equipment will come out small. Steam consumption and cost of equipment will be figured on the basis of commercially practical units, reduced to the conditions of the problem in proportion to the amounts handled (thus eliminating the excess costs of small units per unit capacity). The results will then be strictly comparable among themselves and with the case of single effect operation above. The triple used in Cases *A* and *B*(1) is to work with a 20 deg. temperature drop in the first effect, and evaporate equal amounts in each effect. The single (used in the other cases) is to work on the same coefficient as the first effect of the triple.

As before, case *B*(2) is a nozzle compressor with an 18 deg. drop, case *B*(3*a*) a turbo-blower on a 14 deg. drop, and case *B*(3*b*) a turbo-blower on a 25 deg. drop. The efficiencies are also the same as before.

MULTIPLE EFFECT OPERATION

	Case *A* Triple	Case *B* (1) Triple	Case *B* (2) Single	Case *B* (3*a*) Single	Case *B* (3*b*) Single
Steam raised:					
Power.....	40 lb.	20 lb.	20 lb.	20 lb.	20 lb.
Evaporation.....		20 lb.	20 lb.	20 lb.	20 lb.
Power units and accessories.....	1 kw. non-condensing	1 kw. condensing	1 kw. condensing 1 nozzle	1 kw. condensing 1 kw. condensing and blower	1 kw. condensing 1 kw. condensing and blower
Steam for evaporation:					
Exhaust.....	40 lb.	20 lb.	20 lb.	None	None
Compressed.....	.....	.....	24 lb.	70–80	40
Total.....	40	20	44	70–80	40
Evaporation.....	135 lb.	68 lb.	37 lb.	60–67	34

135 LB. EVAPORATION AND 1 KW. POWER

	Case *A*	Case *B* (1)	Case *B* (2)	Case *B* (3*a*)	Case *B* (3*b*)
Steam:					
Power.....	...	20	20	20	20
Evaporation.....	40	40	73	40–45	80
Total.....	40	60	93	60–65	100
H_2O for condensers:					
Power, lb.....	...	500	500	500	500
Evaporation, lb.....	850	850	3,400	1,000–1,100	2,000
Total.....	850	1,350	3,900	1,500–1,600	2,500
Heating surface.....	3x	3x	3.3x	4.3x	2.4x

Then for a total evaporation of 1,000 gal. per hour as discussed under single effect operation, we would have:

	Case *A*	Case *B* (1)	Case *B* (2)	Case *B* (3*a*)	Case *B* (3*b*)
Total steam needed, lb. per hr. for					
Power.....	3,300	1,650	1,650	1,650	1,650
Evaporation.....	.....	3,300	6,000	3,500	6,800
Total.....	3,300	4,950	7,650	5,150	8,450
Total water used per hr., gal.....	6,300	10,000	29,000	11,500	18,500
Total heating surface, sq.ft.....	1,050	1,050	1,150	1,500	840

	Case *A*	Case *B* (1)	Case *B* (2)	Case *B* (3a)	Case *B* (3b)
First Cost:					
Evaporators	$2,600	$2,600	$2,900	$3,800	$2,100
Power units	3,300	3,450	3,450	3,450	3,450
Blower or nozzle	.....	.....	500	17,000	14,000
Total	$5,900	$6,050	$6,850	$24,250	$19,550
Operating costs per day:					
Fixed charges (20%) per yr., 300 days per year)	$3.90	$4.00	$4.60	$16.20	$13.00
Water at 5c. per 1,000 gal.	7.50	12.00	34.80	13.80	22.20
	$11.40	$16.00	$39.40	$30.00	$35.20
Excess cost over Case *A* per day, exclusive of steam	.....	$4.60	$18.00	$17.60	$13.80
Excess steam used over Case *A*, tons per day	.....	20	56	22	62

Thus, on the assumption of power demands by the plant so large that exhaust enough is furnished to do all the evaporation in single effect, there is a possibility of so combining condensing power units and thermocompression evaporators to show a saving over the usual arrangement. This will be the case only when there is no scaling, no elevation of boiling point, no hot thick liquor withdrawn to the next step, etc. In the ordinary circumstances, thermocompression offers no saving as compared to a single effect, and will be still more expensive if compared to a multiple effect. In general, then, if the power demands of a plant are reasonably in proportion to its demands for steam for evaporation, thermocompression is out of the question except where there is some unusual special condition.

Plants Using Purchased Power

The above discussion is based on the idea that the plant generates its own power. In case the plant generates no power, and central station or hydro-electric power is available, the comparison is different if the price of purchased power is low. Even with moderately expensive power, if the factory has no steam plant and supplies all its power demands with purchased power, it might be more convenient to put in a turbo-blower than to put in a steam plant. On a strict cost basis, however, power would have to be available at a figure very much under the cost of generation in the plant to make the thermocompressor arrangement economical.

Plants With Small Power Demands

The case which is most favorable to the thermocompressor is that of a plant whose evaporation problems call for the use of very much more steam than can be supplied as exhaust from their power units. Here we have four possibilities (after all the exhaust from non-condensing power units has been used): (1) Raise additional low-pressure steam for ordinary evaporators, (2) raise additional high-pressure steam and reduce it for the evaporators with a reducing valve, (3) raise additional high-pressure steam and send it to a condensing turbine driving a turbo-blower, and (4) raise additional steam, send it to a non-condensing turbine driving a turbo-blower, and use the turbine exhaust (along with the compressed vapor) in the evaporator.

Case 1 is evidently out of the question, as it takes very little more heat to raise high-pressure steam than it would to raise 5 to 10 lb. steam. Further, the chance of future needs for high-pressure steam would in any case warrant the slightly greater first cost of the boiler plant designed for high pressures. Let us then assume that the non-condensing turbine takes 40 lb. per kilowatt-hour, the condensing turbine 20 lb., that the turbo-blower will evaporate (*a*) 70-80 lb. per kilowatt-hour and (*b*) 40 lb. and that 1 lb. of steam will evaporate 0.85 lb. of H_2O per effect. Let us assume also that the amount of evaporation is such that a triple or quadruple effect evaporator would be used if case 4 were adopted. Obviously then, in case 4 the first effect would be enlarged. The evaporator may be looked on as a combination of a triple run on exhaust steam and a single with a thermocompressor. The single and the first effect of the triple happen to be combined in one shell, but it is simpler to think of them separately. Let us base our comparison first on 40 lb. of boiler steam, which gives us the following figures:

	Case 2	Case 3	Case 4a	Case 4b
Steam raised, lb.	40	40	40	Same as 4a
Power units	None	2 kw. condensing turbine and blower	1 kw. non-condensing turbine and turbo-blower	Same as 4a
5 lb. steam available for evaporators—exhaust	40	None	40	40
Compressed	None	140–160	70–80	40
Total	40	140–160	110–120	80
Lb. evaporated in single (from compressor)	None	140–160	70–80	40
In triple (from exhaust)	102	None	102	102
Total	102	140–160	170–180	142
Evaporator bodies	3 of x sq.ft. each	1 of $4.5x$ sq.ft.	1 of $3x$ 2 of x sq.ft. each	1 of $2x$ 2 of x sq.ft. each
Total surface	$3x$	$4.5x$	$5x$	$4.2x$
Lb. evaporated per lb. steam	2.55	3.5–4	4.2–4.5	3.7
Condensing water				
Turbines, lb.	None	1,000	None	None
Evaps., lb.	850	None	850	850

If a quadruple be assumed in cases 2 and 4:

Lb. evaporated				
By compressor	None	140–160	70–80	40
By evaporator	135	None	135	135
Total	135	140–160	205–215	175
Condensing water:				
Turbines, lb.	None	1,000	None	None
Evaporators, lb.	850	None	850	850
Heating surface	$4x$	$4.5x$	$6x$	$5.2x$
Lb. evapd. per lb. steam	3.4	3.5–4	5.1–5.4	4.4

Assume an evaporator to remove 30,000 lb. of water per hour in quadruple effect. This would call for about 1,300 sq.ft. per effect, and a steam consumption of 9,000 lb. steam per hour. If the data from the preceding table be converted to equal amounts evaporated, we shall have:

	Case 2	Case 3	Case 4a	Case 4b
Steam, raised, lb. per hour	9,000	8,100	5,800	7,000
Water used, gal. per hour	23,000	24,500	14,500	17,500
Heating surface sq.ft. total	4,200	4,200	4,200	4,200
Hp. of blower turbine	.....	250	150	125
First cost of evaporator	$10,500	$10,500	$10,500	$10,500
First cost of blower and motor	.....	17,000	14,000	12,000
	$10,500	$27,500	$24,500	$22,500
Fixed charges per day (at 20 per cent, 300 working days)	$7.00	$18.30	$16.30	$15.00
Water at 5 cents per 1,000 gal.	27.60	29.40	17.40	21.00
	$34.60	$47.70	$33.70	$36.00
Difference in cost from case 2 (excluding steam)	.....	+13.10	−0.90	+1.40
Steam saved over case 2, tons per day	.....	11	38	24

Hence, in the case where steam cannot be supplied to the evaporators as exhaust from power units, but must be furnished from the boilers, it may be most economically supplied through a turbo-blower driven by a non-condensing turbine. This is in line with the general principle that the most economical method of using steam to produce both power and evaporation is a non-condensing prime mover sending its exhaust to the evaporating device.

Bibliography

In the bibliography which follows every article to which a reference could be found is included, even though the original was not available. Some references were obtained from footnotes where the author did not cite his references accurately. This accounts for the incomplete citations in some cases.

Patents are arranged in numerical order except in the case of the English patents. These are arranged by years and numerically in each year. Where the same

subject is covered by identical patents in different countries, full reference is made and subject given under the first entry, and succeeding notices refer back to that one. Foreign patents have not been examined other than by the literature references. All U. S. patents have been examined in the specifications themselves.

An asterisk indicates mention by title only, or an abstract so brief as to be useless.

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LIST OF ARTICLE REFERENCES ON VAPOR, RECOMPRESSION EVAPORATION

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2	Anon.	*J. Soc. Chem. Ind.*, vol. 36, pp. 70-2 (1917).	Description of Soderlund and Boberg and Prache evaporators.
3	Anon.	*Z. Bayer. Revisionsver.*, 1918, p. 176. *Chem. App.*, vol. 6, p. 12 (1919).	
4	Anon.	*Eng.*, vol. 102, pp. 637-40, 642 (1916). *Chem. Abs.*, vol. 11, p. 691 (1917).	Description of Prache and Bouillon evaporators with illustration.
5	Anon.	*Am. Sug r Ind.*, vol. 13, p. 538 (1911).	Abstract of No. 17.
6	Balzberg	*Oesterr.-Z. Berg.-Hüttenwesen*, 1878.	Piccard-Weibel system in salt plant.
7	Bue	*Bull. Assoc. Chim. Sucr. Dist.*, vol. 39, pp. 38-40 (1921). *Chem. Abs.*, vol. 16, p. 1023 (1922)*.	
8	Carlsson	*Chem. & Met.*, vol. 24, p. 645 (1921). *Chem. Abs.*, vol. 15, p. 202 (1921).	Description of a Kummler-Matter installation and theoretical discussion.
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11	Cunze	*Z. Ver. deut. Zuckerind.*, vol. 32, pp. 541-2 (1882).	The Piccard-Weibel process.
12	Dahme	*Z. Dampfkessel Masch.*, 1920, p. 153.	The "Heat Pump."
13	de Baufre	*J. Am. Soc. Mech. Eng.*, vol. 40, p. 746 (1918). *Chem. Abs.*, vol. 12, p. 2666 (1918).	Abbreviated discussion of No. 39.
14	Deerr	"Cane Sugar," 2nd Ed. 1921, pp. 354-6.	General review.
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16	Deinlein	*Z. Bayer. Revisionsver.*, 1919, No. 24.	The "Heat Pump."
17	Eslancher	*J. Fabr. Sucr.*, 1911, Sept. 13.	Tests of Prache & Bouillon nozzle and sugar installation. See No. 5.
18	Flügel	*Z. Ver. deut. Ing.*, vol. 64, pp. 954-8, 986-9 (1920).	General theoretical comparison of various systems.
19	Fürer	*Salzbergbau u. Solinenkunde*, 1900, p. 897.	
20	Holmes	*Paper Maker & Paper Trade J.*, 1922, pp. 610-8. *Chem. Trade J.*, vol. 70, pp. 1-3, 1922. *Chem. Abs.*, vol. 16, p. 1505 (1922)*.	General discussion.
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33	Schreber	*Chem. Ztg.*, vol. 44, pp. 469-70 (1920). *Chem. App.*, vol. 8, p. 158 (1921).	
34	Schreber	*Z. Dampfkessel Masch.*, 1920, pp. 45-52.	
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36	Schroeder	*Chem. App.*, vol. 2, pp. 187-9 (1915).	Early history, Prache & Bouillon evaporators.
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44	Whitehead	*Sugar Cane*, vol. 12, p. 424 (1880).	
45	Wirth	*Bull. Schw. Elektrotech. Vereins*, 1919, p. 12.	Kummler & Matter evaporators.
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LIST OF AMERICAN, GERMAN, FRENCH AND ENGLISH PATENTS ON VAPOR RECOMPRESSION SYSTEMS FOR EVAPORATORS

No.	Patent No.	Patentee	Date	Other Patent References	Lit. References	Subject
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101	896,460	Prache	Aug. 18, 1908	Fr. 364,408 German 180,115 English 26,065-1905	*J. Soc. Chem. Ind.*, vol. 27, p. 929 (1908)*.	Vertical evaporator with compartments.
102	904,276	Prache & Bouillon	Aug. 18, 1908			Nozzle.
103	1,020,659	Prache & Bouillon	Aug. 18, 1908	Fr. 485,851 English 14,492-1911 German 258,010		Crystallizing evaporator.
104	1,071,341	Prache	Aug. 26, 1913	German 267,270 Fr. 450,135 Eng. 25,458-1902	*J. Soc. Chem. Ind.*, vol. 32, p. 900 (1913)*. *Sugar*, vol. 16, March, p. 61 (1914).	Inclined evaporator with superimposed compartments.
105	1,150,713	Soderlund	Aug. 17, 1915	Fr. 444,109 Eng. 12,462-1911	*J. Soc. Chem. Ind.*, vol. 34, p. 947 (1915)*. *Z. Ver. deut. Zuckerind.*, vol. 66, p. 117 (1916).	Horizontal tube film evaporator in stages.
106	1,200,996	Soderlund	Oct. 10, 1916	Fr. 449,399 Eng. 22,670-1911	*J. Soc. Chem. Ind.*, vol. 35, p. 1145 (1916)*. *Z. Ver. deut. Zuckerind.*, vol. 67, p. 171 (1917)*	Film type evaporator.
107	1,213,596	deBaufre	Jan. 23, 1917	Eng. 114,164	*J. Soc. Chem. Ind.*, vol. 36, p. 376 (1917).	Application of nozzle to evaporator.
108	1,252,962	Soderlund & Boberg	Jan. 8, 1918			Vertical tube film evaporator
109	1,361,834	deBaufre	Dec. 14, 1920			Application of multiple nozzles to evaporator.
110	1,390,676	deBaufre	Sept. 13, 1921			Application of nozzles to multiple effect evaporator.
111	1,390,677	deBaufre	Sept. 13, 1921			Similar to preceding.
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117	267,270	Prache	Nov. 19, 1911	U. S. 1,071,341	*Z. Ver. deut. Zuckerind.*, vol. 63, p. 1086 (1913). *Chem. Abs.*, vol. 8, p. 597 (1914)*.	
118	268,861	Prache & Bouillon	May 15, 1912		*Chem. Abs.*, vol. 8, p. 2041 (1914)*.	
119	270,471	Prache	Feb. 22, 1912	Fr. 453,995	*Z. Ver. deut. Zuckerind.*, vol. 64, p. 407 (1914). *Chem. Abs.*, vol. 8, p. 2231 (1914)*.	Use of gas engine to compress vapors

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121	339,177	Montupet & Jannin	July 27, 1906	Addition to preceding	*J. Soc. Chem. Ind.*, vol. 25, p. 840 (1906). *Z. Ver. deut. Zuckerind.*, vol. 56, p. 972 (1906).	Regulation of nozzles.
122	350,409	Sautter, Harle, & Cie.	Feb. 1, 1906		*Z. Ver. deut. Zuckerind.*, vol. 56, p. 374 (1906).	Use of turbo-blower.
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124	356,752	Theisen	Aug. 8, 1905	Ger. 167,422	*Z. Ver. deut. Zuckerind.*, vol. 56, p. 169 (1906). *J. Soc. Chem. Ind.*, vol. 25, p. 8 (1906).	
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132	19,385	Theisen	Sept. 25, 1905	Ger. 167,422	*J. Soc. Chem. Ind.*, vol. 25, p. 524 (1906).	
133	26,065	Prache & Bouillon	Dec. 14, 1905	U. S. 896,460	*J. Soc. Chem. Ind.*, vol. 26, p. 39 (1907).	
134	9,276	Prache	Apr. 19, 1909		*J. Soc. Chem. Ind.*, vol. 29, p. 677 (1910).	Inclined horizontal evaporator.
135	12,462	Soderlund & Testrup	May 23, 1911	U. S. 1,150,713	*J. Soc. Chem. Ind.*, vol. 31, p. 971 (1912). *Chem. Abs.*, vol. 6, p. 3039 (1912).	
136	14,492	Prache	June 19, 1911	U. S. 1,020,659	*J. Soc. Chem. Ind.*, vol. 31, p. 112 (1912)*. *Chem. Abs.*, vol. 7, p. 4 (1913)*.	
137	22,670	Soderlund	Oct. 14, 1911	U. S. 1,200,996	*J. Soc. Chem. Ind.*, vol. 32, p. 183 (1913). *Chem. Abs.*, vol. 7, p. 1119 (1913)*.	
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139	25,711	Sudfeldt und Co.	Nov. 8, 1912		*J. Soc. Chem. Ind.*, vol. 32, p. 408 (1913).	Use of nozzle and superheated steam.
140	4,515	Prache	Feb. 21, 1913		*Chem. Abs.*, vol. 8, p. 2641 (1914)*.	
141	13,607	Boberg, Soderlund & Testrup	June 12, 1913		*J. Soc. Chem. Ind.*, vol. 33, p. 906 (1914).	Use of gas engine for power for compressor.
142	3,456	Soderlund, & Boberg	Feb. 10, 1914		*J. Soc. Chem. Ind.*, vol. 34, p. 295 (1915). *Z. Ver. deut. Zuckerind.*, vol. 66, p. 438 (1916). *Chem. Abs.*, vol. 8 p. 2160(1915).	Use of gas engine for power for compressor.
143	138,871	Metallbank und Metallurgische Co.	Feb. 9, 1920		*Chem. Abs.*, vol. 14,p. 1877 (1920)	Use of turbo-blower and spray evaporator.
144	25,458	Prache	Nov. 6, 1912	U. S. 1,071,341	*J. Soc. Chem. Ind.*, vol. 32, p. 275 (1913). *Chem. Abs.*, vol. 8, p. 1361 (1914)*.	
145	114,164	deBaufre	Oct. 24, 1916	U. S. 1,213,596	*J. Soc. Chem. Ind.*, vol. 37, p. 231A (1918)*.	
146	124,732	Matter	Mar. 17, 1919		*J. Soc. Chem. Ind.*, vol. 38, p. 750A (1919).	Use of several bodies and one compressor.
147	123,716	Kummler & Matter	Oct. 24, 1918		*J. Soc. Chem. Ind.*, vol. 39, p. 287A (1920).	Using part of compressed vapor in open steam jet.

Growth of Canadian Paper Industry

After the depression of 1921 the present year has seen a remarkable expansion in the Canadian pulp and paper industry. For the year ended April 1, 1922, pulp and paper exports had a total value of over $180,000,000, a figure exceeded only by exports of wheat and agricultural products. The Canadian newsprint mills now have a rated capacity of about 5,520 tons per day, equivalent to an output of 1,250,000 tons per year, which is double the output of any year prior to 1917. In addition, Canadian mills are equipped to produce 2,500 tons of pulp daily. The combined output represents a daily cut of 6,000 acres of forest land.

The Canadian pulp and paper industry is, in fact, accomplishing so much that it is a difficult matter to keep accurate trace of it, and statistics which apply today may be entirely incorrect tomorrow. According to government figures for 1920, the industry employed an invested capital of over $347,000,000, of which slightly more than half was in the Province of Quebec. In the first 6 months of 1922 Canadian mills produced over 516,000 tons of newsprint, as compared with 612,000 produced by the United States mills. The Canadian newsprint output during this 6 months period is stated to have been 93.6 per cent of mill capacity.

While the volume of United States newsprint production has remained practically stationary at around 1,300,000 tons since 1913, Canadian production has increased from 350,000 tons to 812,000 tons in the same time. Exports to the United States have increased from 219,602 tons to 791,978 tons. The United States has, in fact, come to depend on Canada for 85 per cent of the newsprint in addition to huge quantities of pulp. There is also an extensive trade being built up, and increasing rapidly, with the antipodes and the Orient, and in this regard the Pacific coast as a pulp and paper area is fast developing in importance. Total pulp and paper exports for the month of June this year amounted in value to $10,534,896, and for July $9,738,252. Production in the latter month was nearly double that of the corresponding month in 1921, though, due to lower prices, the value was only slightly increased.

Bauxite in 1922

The domestic production of bauxite in 1922 was at least twice as large as in 1921 and may reach a total of not less than 300,000 long tons, according to the Geological Survey. This quantity is about half of that normally consumed.

During the first 6 months of 1922 the imports of bauxite averaged about 1,500 long tons a month, but since June they have been more than 3,000 tons a month. The prices of domestic dried bauxite ranged from $6 to $10 a ton, but were lower in the last half of the year. The prices of pulverized and dried bauxite have ranged from $12 to $15 a ton, and of calcined from $20 to $25 a ton. The effect of a shortage of coal is reflected in an increase in the price of calcined bauxite during the latter part of 1922. Under the new tariff the duty on bauxite is $1 a ton, whereas under the old tariff it was on the free list.

Materials for Furnaces and Ovens

Safe Temperature Ranges, and Data on Ability to Transmit Heat

DESIGNERS and constructors of ovens and furnaces, especially those operated by electric current, will find a great deal to interest them in a paper read by E. F. Collins, of the General Electric Co., before the Montreal meeting of the American Electrochemical Society, entitled "Electric Heat, Its Generation, Propagation and Application to Industrial Processes." The author calls attention to the fact that heat, light and electricity are only different manifestations of energy, and their phenomena follow identical laws. He then goes on to show how equations for the flow of electricity are analogous to those for the flow of heat. A number of tabulations of physical constants are given, so that a person familiar with the mathematical development can apply the theoretical expressions to given combinations of furnace materials.

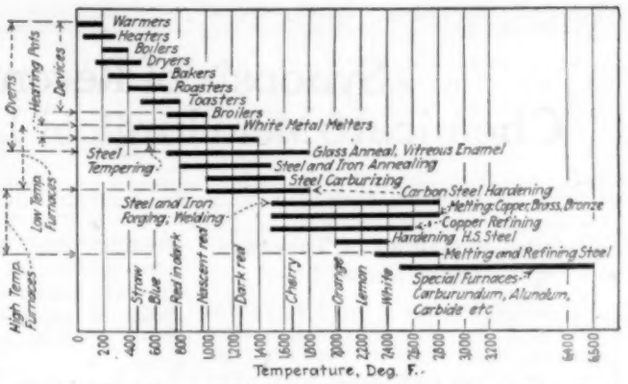

FIG. 1—TEMPERATURE RANGE IN INDUSTRIAL PROCESSES

We reproduce two of the simpler diagrams in Figs. 1 and 2. They chart in a very clear manner the capabilities and limitations of various materials of construction, and the duty demanded of different kinds of ovens or furnaces.

Another chart shows the limitations of the materials of construction when used in electrically heated equipment. These data are contained in Table I.

TABLE I—LIMITATIONS OF MATERIALS

Material	Maximum Operating Temp., Deg. F.	Melting Temp., Deg. F.	
Resistors			
Tungsten	3,400	.....	Oxidizes rapidly
Molybdenum	3,400	.....	Oxidizes rapidly
Carbon	3,400	.....	Oxidizes rapidly
Silundum	3,400	.....	.....
Platinum	3,000	.....	.....
Nickel-chromium alloy	2,200	.....	.....
Aluminum steel	1,600	.....	.....
Nickel	1,400	.....	.....
Iron	600	.....	.....
Refractories			
Firebrick	2,900	2,900	.....
Silica brick	3,100	3,100	.....
Chromite brick	3,400	3,950	.....
Magnesite brick	3,400	4,000	.....
Carborundum and alundum	3,400	4,060	.....
Heat insulators			
Magnesia	1,200	.....	.....
Asbestos	800	.....	.....
Kieselguhr	1,000	.....	.....
Red brick	400	.....	.....
Air cells	700	.....	.....
Electrical insulators			
Porcelain	200	.....	.....
Mica	800	.....	.....
Fire clay	1,000	.....	.....
Magnesium oxide	1,400	.....	.....
Asbestos	1,000	.....	.....
Alundum	2,400	.....	.....
Containers and Carriers			
Cast iron	1,000	.....	.....
Malleable iron	800	.....	.....
Steel	600	.....	.....
Nickel-chromium alloy	2,200	.....	.....
Monel metal	1,000	.....	.....
Non-metallic refractories	2,800	.....	.....
Calorized steel	1,600	.....	.....

Hardening of Duralumin

'An Investigation of Duralumin" has been undertaken by S. Konno, under the direction of K. Honda, and the results of his findings are published in the *Science Reports* of the Tohoku Imperial University, vol. 11, p. 269. He finds that the heating, quenching and aging phenomena are exactly similar to those when heating, scverely quenching and tempering carbon steels. Hardening is due to the presence of the several elements and their possible compounds, present either by design or as impurities; but the aging effect is due principally to the dissolution of Mg_2Si in aluminum. Al_2Cu acts similarly, but to a very minor extent. Additions of Cu and Mn (duralumin) increase the hardness of Al:Mg alloys, but not the aging effect.

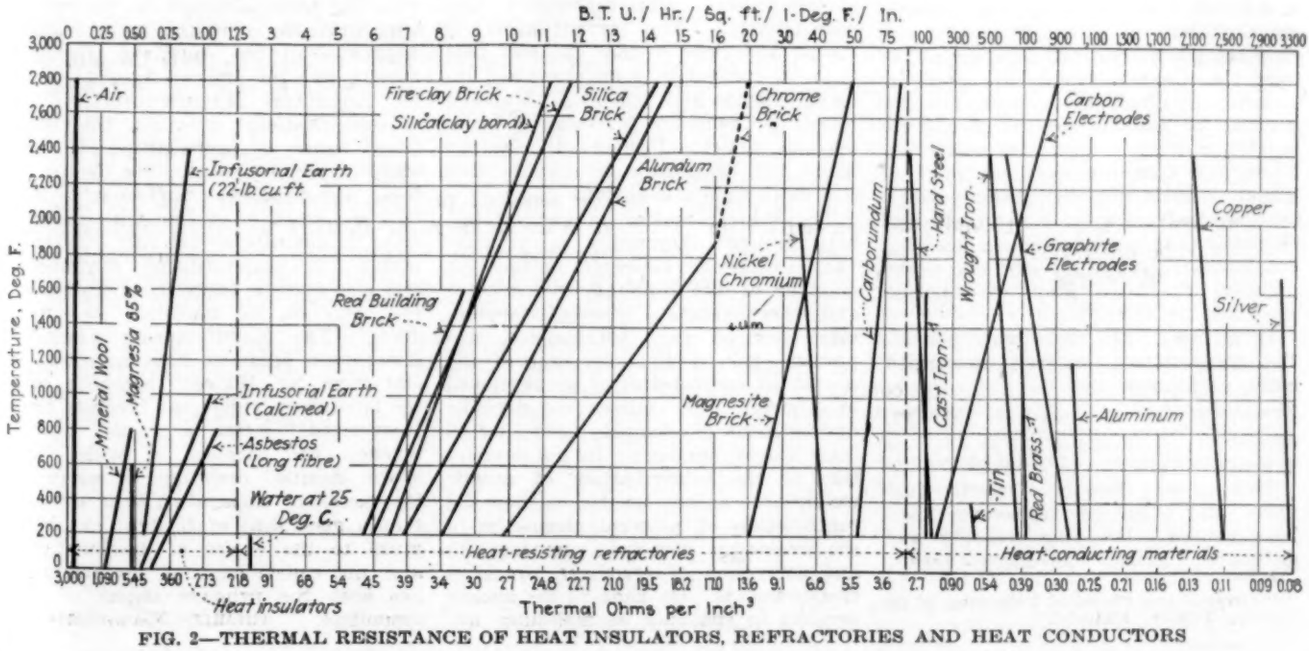
B. T. U. / Hr. / Sq. ft. / 1-Deg. F. / In.
0 0.25 0.50 0.75 1.00 1.25 3 4 5 6 7 8 9 10 11 12 13 14 15 16 20 30 40 50 75 100 300 500 700 900 1,100 1,300 1,700 2,100 2,500 2,900 3,300
Temperature, Deg. F.
3,000 2,800 2,600 2,400 2,200 2,000 1,800 1,600 1,400 1,200 1,000 800 600 400 200 0
Air
Infusorial Earth (22-lb. cu. ft.
Mineral Wool
Magnesia 85%
Infusorial Earth (Calcined)
Asbestos (Long fibre)
Water at 25 Deg. C.
Fire-clay Brick
Silica Brick
Silica-clay bond
Alundum Brick
Chrome Brick
Real Building Brick
Nickel Chromium
Magnesite Brick
Carborundum
Hard Steel
Cast Iron
Wrought Iron
Tin
Red Brass
Carbon Electrodes
Graphite Electrodes
Copper
Silver
Aluminum
Heat-resisting refractories
Heat-conducting materials
Heat insulators
3,000 1,090 545 360 273 218 91 68 54 45 39 34 30 27 24.8 22.7 21.0 19.5 18.2 17.0 13.6 9.1 6.8 5.5 3.6 2.7 0.90 0.54 0.39 0.30 0.25 0.21 0.16 0.13 0.11 0.09 0.08
Thermal Ohms per Inch³

FIG. 2—THERMAL RESISTANCE OF HEAT INSULATORS, REFRACTORIES AND HEAT CONDUCTORS

Synopsis of Recent Chemical & Metallurgical Literature

Freezing or Galling of Threaded Pipe Joints

Couplings for heavy welded pipe of steel—such as oil well casings—have ordinarily been made of wrought iron. It is the usual experience that when coupling and pipe of the same metal are screwed together with considerable force, the joint will oftentimes seize or "gall" before many turns. This is really nothing but a low-temperature welding at excessive pressure. In a recent paper[1] before the American Petroleum Institute, F. N. Speller finds that steel couplings and pipe having die-cut threads can be driven three or four turns further than ordinarily if the coupling threads have previously been electroplated with zinc. Nearly as good results may be had by mixing a grease with 50 per cent by weight of zinc dust, and using this as lubricant.

Nickel and Chromium in Cast Iron

Richard Moldenke presented a paper on this subject before the San Francisco meeting of the Mining Engineers (September, 1922). It contains a summary of extended tests on standard bars made of various mixtures of cast irons containing up to 20 per cent of Bethlehem Steel Co.'s Mayari pig. He points out that this pig iron contains high carbon (4.25 per cent total) 1.2 per cent Ni, 2.4 Cr and 0.2 Ti, and is smelted with a large slag volume and heavy coke charges. All these are indications of a well-made iron, free of oxide, even approaching the general excellence of the older "charcoal irons"; and should produce castings of fine uniform grain.

When introduced into a cupola, about half the Cr is slagged; Ni persists, however. Chromium decreases the amount of graphic carbon in the resulting castings; nickel increases the strength. Large proportions of low-silicon Mayari pig will produce excellent white iron rolls, car wheels and crusher liners. Castings containing considerable Ni and Cr will also prove superior for heat- and acid-resisting purposes.

In all about 245 heats were poured, the compositions varying systematically, as follows:

Phosphorus	0.10; 0.40; 0.80
Total carbon	2.75; 3.25; 3.75
Silicon	0.75 to 2.75 by 0.25 steps
Mayari pig additions	0, 10, 15 and 20 per cent

Melting was done in a crucible furnace, and standard transverse test-bars poured. Breaking strength and deflection, Brinell hardness, tensile strength and chemical composition were determined for each heat. Results are tabulated in the paper, and a series of graphs drawn showing the effect of composition on these properties.

In general it was found that the Brinell hardness decreases as the total carbon increases, and is independent of the silicon content. Hardness and transverse strength also seem to be independent properties.

Silicon seems to weaken the transverse bars, as does also high total carbon and high phosphorus. On the other hand, nickel and chromium increase the strength, especially in low percentages. The strongest bars broke at about 4,900 lb. with a deflection of about 0.11 in. They contained total carbon about 3.25, Si 1.75 per cent, P less than 0.40 and Ni and Cr about 0.15 per cent each. This strength is about 600 lb. greater than similar analysis containing no Ni and Cr, although low-phosphorus irons containing no alloy showed superior ductility.

[1] "Physical and Chemical Properties of Oil Country Tubular Material."

Book Reviews

OUTLINES OF THEORETICAL CHEMISTRY. By *Frederick H. Getman*. Third edition, thoroughly revised. xi + 625 pp., illustrated. John Wiley & Sons, New York. Price, $3.75.

The broad field of physical chemistry is completely covered—the properties of the different physical states of matter, equilibrium, thermochemistry, photochemistry, electrochemistry and radioactivity. The arrangement is logical and clear so that one sees that physical chemistry is an organized integral science and not, as in Walker's Physical Chemistry, a series of independent topics. Perhaps the author might well have made his classification still more rigid and obvious.

The subject matter in general has been brought thoroughly up to date (e.g., isotopes). However, no mention is made of the Bingham viscosimeter and other important types of viscosimeter; nor of the Menzies b.p. apparatus, nor of plasticity, nor of the science of microchemistry as developed by Chamot. One misses the periodic arrangement of elements according to their atomic numbers. In the description of the determination of atomic weights the author omitted to show the contribution of physical chemistry in the avoidance, decrease, compensation and correction of errors in precision measurements. On page 85 the author persists in speaking of molecular aggregates within a solid crystal and he ascribes to them a sort of Brownian movement. Like most texts upon physical chemistry, this book does not show explicitly how to use Van der Waal's equation and how to calculate the constants, and no problems upon this important and practical equation are given. The chapters upon electrical conductance and electromotive force have been, to a large extent, abstracted from LeBlanc's Electrochemistry, which is a book that has long needed revision. Electrometric titration and the concentration of hydrogen ions and pyrometry have been cursorily treated.

The book is convenient in form, the printing is clear and the paper is good. The diagrams and curves are abundant (148 figures), well selected and clear.

The text is adapted (and intended) for those who are beginning the study of physical chemistry. The student who has already received, according to modern practice, some instruction in physical chemistry in his courses in general chemistry, qualitative analysis and quantitative analysis will not be too advanced to use this book. It should serve very well as a text to teach from, as well as a book for self-study or for a review. Probably it is one of our best three texts of introductory physical chemistry.

RESTON STEVENSON.

STANDARD SPECIFICATIONS FOR LABORATORY APPARATUS ADOPTED BY THE MANUFACTURING CHEMISTS ASSOCIATION OF THE UNITED STATES.

These pamphlets are on sale at the office of the Manufacturing Chemists' Association in the Woodward Building, Washington, D. C. The price is not given, but is probably moderate. A committee of the Manufacturing Chemists Association, of which E. C. Lathrop of the du Pont company was chairman, has worked out, together with the manufacturers of laboratory apparatus, the committee on laboratory apparatus of the American Chemical Society and the Official Association of the Apparatus Manufacturers, a set of specifications covering the more usual types of apparatus. It will scarcely pay to go into the details of these specifications. Suffice it to say that the work is in line with modern ideas of diminishing the cost of manufacture by standardizing equipment, and also gives a happy combination of the ideas of the consumer and producer. The Manufacturing Chemists Association seems to have borrowed a leaf from Mr. Hoover's notebook, and the laboratory apparatus becomes thus Hooverized. After a casual glance through the catalog, in which are shown detailed drawings of many of the pieces of apparatus, it is evident that a good deal of thought has been given to the choice of specifications, and the convenience of the operator has been the primary slogan of the committee. CHARLES WADSWORTH.

Recent Chemical & Metallurgical Patents

American Patents Issued Dec. 26, 1922

The following numbers have been selected from the latest available issue of the *Official Gazette* of the United States Patent Office because they appear to have pertinent interest for *Chem. & Met.* readers. They will be studied later by *Chem. & Met.'s* staff, and those which, in our judgment, are most worthy will be published in abstract. It is recognized that we cannot always anticipate our readers' interests and accordingly this advance list is published for the benefit of those who may not care to await our judgment and synopsis.

1,439,683—Manufacture of Gasoline. R. F. Bacon and B. T. Brooks, Pittsburgh; assigned to Gulf Refining Co., Pittsburgh.

1,439,685—Production of Light-Colored Fatty Acids. J. W. Bodman, Western Springs, Iowa; assigned to William Garrigue & Co., Inc., New York City.

1,439,781—Crusher. M. F. Williams, St. Louis; assigned to Williams Patent Crusher & Pulverizer Co. of Missouri.

1,439,865—Nickel Alloy. Leon Cammen, New York City; assigned to International Nickel Co. of New Jersey.

1,439,887—Vehicle for Paint Pigments. William G. Hall, California, Pa.

1,439,909—Production of Alkali Metal Cyanides. F. J. Metzger, New York City; assigned to Air Reduction Co., New York City.

1,439,921—Recovery of Gasoline From Natural Gas. E. A. Starke, Berkeley, Calif.

1,439,939—Low Percentage Manganese Steel. J. M. Blake, Chicago Heights, Chicago, Ill.; assigned to American Manganese Steel Co., Chicago, Ill.

1,439,960—Purification of Hydrofluoric Acid. Henry Howard, Cleveland; assigned to Grasselli Chemical Co., Cleveland, Ohio.

1,439,976—Conversion of Aromatic Ring Compounds Into Motor Spirit. A. S. Ramage, Detroit, Mich.; assigned to Chemical Research Syndicate, Ltd., Detroit.

1,440,006—Cellulose Acetate Composition. H. Dreyfus, London, England.

1,440,026—Evaporator for Acid Generating Liquids. H. A. E. Nilson, Sweden.

1,440,056—Making Urea Phosphate. F. Clarkson and J. M. Braham, Washington, D. C.

1,440,063—Guanidine Nitrate. T. L. Davis, Somerville, Mass.

1,440,018—Recovery of Phenol Vapors by Tar Oils. W. Runge, Orange, and H. A. Curtis, Maplewood; assigned to Bregeat Corp. of America, Wilmington, Del.

1,440,176—Vulcanizing Rubber. Eloi Ricard, Melle, France; assigned to Société Ricard, Allenet & Cie., Melle (Deux Sèvres), France.

1,440,194—Drying, Burning and Recovering of Finely Divided Material. Abraham Wijnberg, Amsterdam, Netherlands.

1,440,195—Same title as 1,440,194.

1,440,211—Continuous Process for Manufacture of Caustic Soda and Caustic Potash. Camille DeGuide, Enghien, France.

1,440,256—Treatment of Hydrocarbons. G. F. Forwood, London, England; assigned to the United Kingdom Oil Co., Ltd., London.

1,440,352—Treatment of Oil Containing Water. O. C. Gatrell, El Dorado, Kan.

1,440,355 and 1,440,356 — Suspension and Emulsion and Process for Making Same. J. C. Morrell, New York City.

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Diolefine Polymerization Products—It has been known that by passing a mixture of acetylene and propylene through red hot tubes it is possible to obtain small quantities of 1.3 butadiene together with other hydrocarbons. Furthermore, the formation of diolefine is increased by use of contact agents and is probably influenced by the catalytic activity of other substances. Hermann Plauson, however, claims to have produced increased yields of these condensation products by gradually increasing the pressure and the temperature, or increasing the time of reaction. He submits a mixture of equal volumes of acetylene and ethylene to a pressure of from 3 to 15 atmospheres by forcing them into a long thick-walled spiral or zigzag steel tube. This is heated from the outside to 350-450 deg. C. By a special arrangement of the valves at the ends of the tube, the gases are permitted to escape as any desired pressure is obtained. The gases which escape are passed into a distillation apparatus and are first cooled with water and then in a freezing machine to 20 deg. C. The 1.3 butadiene and the higher boiling hydrocarbons are thus condensed from the unchanged gases, which are forced back into the tube by means of the compressor.

A second example cited by this patent involves the use of molecular proportions of allylene and ethylene, from which is obtained a diolefine hydrocarbon of the formula C_5H_8. When treated with metallic sodium, this compound is polymerized to yield a rubber-like product. A yield of 8 to 12 per cent is said to be obtained by a single passage of the gaseous mixture through the apparatus, and the total yield with continuous operation is about 75 to 78 per cent. Other examples cite the use of mixtures of acetylene and propylene and of ethylene, acetylene and benzene. The polymerized products obtained from each of these mixtures are said to be of use in oil varnishes and as turpentine substitutes. (1,436,819. Nov. 28, 1922.)

Varnish Compositions—An application of the Plauson colloid mill in the manufacture of varnish and similar paintable compositions is claimed in a recent patent granted to the mill's inventor, Hermann Plauson, of Hamburg, Germany. In general, the process consists of subjecting a mixture of a varnish base, a liquid dispersion medium and some sort of a dispersion accelerator to intensive mechanical disintegration, such as that obtained in the colloid mill which reaches a peripheral speed of about 2,000 meters per minute. According to one of the examples cited, 100 parts of benzene is mixed with 5 to 10 parts of acetone-soluble condensation products of the phenol-formaldehyde type, which have previously been treated with small quantities of acetone, in the presence of 1 to 5 per cent of a fossil resin. The mixture is disintegrated in the colloid mill. The suspension gradually begins at a peripheral speed of about 300 meters per minute, but is carried out satisfactorily only at a speed of about 1,500 to 2,500 meters per minute. This treatment is to be continued for 3 hours at a temperature not over 70 deg. C. The result is a homogeneous lacquer which is not a true solution of the base in benzene, but is a suspensoid colloidal dispersion. Varnishes similar to shellac can be obtained from other artificial resins, such as the oxidized pitches, cumarone resins, vinyl polymerization products, etc., or from natural resins, such as copal, asphalt colophony, etc.

The products described in this patent differ from ordinary varnishes in that the particles are so finely divided that they possess the power of remaining in permanent colloidal suspension. Although in practice they may be considered as ordinary solutions, they are in reality suspensoid colloids. (1,436,820. Nov. 28, 1922.)

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Oils, etc.—Mineral and other oils and fats are increased in consistency by the addition of a saponifying agent and a product obtained by partly splitting two or more fats or oils with sulphoaromatic acids. These fats or oils are preferably split to an extent of not more than 50 per cent, the resulting mixture of substances being used without any separation. Only one of the oils may be split by means of sulphoaromatic acids, the other one being split by any other reagent. One of the two oils is preferably castor oil. In an example, 5.75 kg. of castor oil is split to the extent of 43½ per cent by means of Twitchell reagent and 1.75 kg. of fish oil are added. The mixture is added to 100 kg. of a light mineral oil together with 8 kg. of 40 per cent soda lye. (Br. Pat. 185,782. Meyer zu Eissen and P. Kiederich, Berlin. Nov. 8, 1922.)

Motor Fuel—Naphthene acid, preferably purified, is added as a diluent to hydrocarbons in amounts of at least 5 per cent and up to 40 per cent by volume to form a motor fuel; or the acid is used in the form of its neutral or acid soaps to form fuels of the type described in specification 12325/14 in which water is incorporated as an emulsion. Cresol or carbolic acid or other phenols, preferably in proportions of 1 to 3 per cent by volume, or amyl or ethyl alcohol may also be added to the

water-containing fuels to render the mixtures stable. Examples specify the use of potash and ammonia soaps of naphthene acid, and of benzol with gas oil or kerosene oil. Preferably, the naphthene acid is added to the oil, the mixture treated with alkali, and the water added subsequently. (Br. Pat. 185,796. H. Kleinschmidt, Berlin. Nov. 8, 1922.)

Tin Electrolysis—An electrolyte for refining tin consists of an acid, preferably hydrofluosilicic acid, in which tin is dissolved and to which a relatively small proportion of phosphoric acid is added to render insoluble any lead contaminating the tin. The electrolyte is prepared by intermittently immersing baskets made of impure tin or hard rubber containing impure shot tin in oxidizing tanks containing a 15.5 per cent solution of hydrofluosilicic acid until the solution has taken up 4.5 per cent of its weight of tin; the baskets are then suspended above the tanks until it is necessary to regenerate the solution. The solution is continuously circulated between the oxidizing and the electrolytic tanks by a pump. Phosphoric acid is added before solution and from time to time during electrolysis; the proportion may be from 0.1 to 0.3 per cent; about 0.1 per cent of cresylic acid, and from 0.05 to 0.1 per cent of glue may also be added. Slabs of impure tin are used as anodes and sheets of pure tin as cathodes. Both sets of tanks are lined with asphaltum paint. (Br. Pat. 185,808. W. P. Thompson, Liverpool. Nov. 8, 1922.)

Treating Copper-Nickel Solutions—A process for the precipitation of copper by means of finely divided nickel from solutions containing copper and nickel is carried out at a temperature below that of exhaustion of the nickel. Bessemerized copper-nickel matte may be ground, roasted and leached with sulphuric acid; part of the leached residue is reduced to metal and is used in excess as a precipitant for the solution obtained from the remainder of the leached residue, the precipitation being carried out at normal temperatures, and preferably on the counter-current principle. The copper-nickel powder with the copper cemented thereon is roasted, preferably in admixture with roasted or unroasted matte. The process may be applied to the removal of copper from any nickel sulphate solutions and electrolytes—for example, in cyclic processes—so that heating and subsequent cooling are avoided. In the separation of nickel and copper by electrolysis, the nickel sulphate electrolyte containing sulphuric acid may be supplied to the cathode compartment and passed through a filtering diaphragm to the anode compartment, the impure nickel-copper solution formed being drawn off, purified as described above, and returned to the cathode compartment. (Br. Pat. 185,859. H. G. C. Fairweather, London. Nov. 8, 1922.)

Pyrazolone Dyes—Direct dyeing cotton dyestuffs of the tartrazine type are obtained (*a*) by condensing two molecular proportions of an aryl-benzthiazole hydrazine with one molecular proportion of dioxytartaric acid, (*b*) by coupling a diazo aryl-benzthiazole with a pyrazolone derived from an aryl-benzthiazole and acetoacetic or oxalacetic ester. An example of each method is given using (1) dehydrothiotoluidine monosulphonic acid and dioxytartaric acid, (2) diazotized dehydrothiotoluidine monosulphonic acid and the pyrazolone obtained by condensing the hydrazine from dehydrothiotoluidine monosulphonic acid with acetoacetic or oxalacetic ester; the products dye cotton orange shades fast to light and washing. (Br. Pat. 185,880. J. Baddiley, J. B. Payman and E. G. Bainbridge; assignors to British Dyestuffs, Ltd. Nov. 8, 1922.)

Leuco Vat Dyes—Reduction products of vat dyes (indigo, thioindigo, indanthrene, etc.) are converted into enolic ethereal salts which are stable in air, by the reaction of acids with the hydroxyl groups of the said reduction products. The conversion may be effected by general methods—for example, by action of an acid chloride on the leuco dyestuff in the presence of a tertiary base. The ethereal salts of sulphuric acid are obtained by the use of chlorsulphonic acid in the presence of a tertiary base, the product being then converted into a stable salt. In an example, dihydro-indigo is added to a pyridine solution of chlorsulphonic acid in an atmosphere of carbon dioxide and the mass diluted with water and crystallized; the pyridine salt so obtained is converted into an alkali or other salt.

Animal or vegetable fibers are dyed or printed with the above described compounds which are converted on the fiber into the dyestuffs by hydrolysis and oxidation, or by treatment with an oxidizing agent only; the latter method is available particularly in the case of sulphuric acid derivatives of dihydro-indigo and dihydro-thioindigo, which are hydrolyzed and oxidized simultaneously by ferric chloride, bromine, chloride of lime, or the like, even in neutral solution. (Br. Pat. 186,057; not yet accepted. Durand et Huguenin, Soc. Anon., Basel. Nov. 8, 1922.)

Oil Emulsions—Oils, particularly mineral and tar oils, are subjected to high-speed disintegration in a colloid mill, such as that described in specification 155,836, in presence of water and of an insoluble mineral solid—for example colloidal graphite, calcined magnesia or magnesium carbonate. Talc or graphite may be added to increase the consistency of the product. Pastes are obtained when not more than 6 parts of water to 1 part of oil are employed; liquid emulsions when the water exceeds this proportion. The products are suitable for use as lubricants. Four typical compositions are as follows: (1) 1 part of viscous hydrocarbon oil, 1 part of colloidal graphite, 1 to 2 parts of water, and 1 to 3 per cent of coco-butter or like fat; (2) 1 part of low-temperature tar oil, 3 to 4 parts of water, and ½ to 2 per cent of magnesium carbonate, with or without 1 to 2 parts of graphite or talc; (3) 1 part of tar oil from Saxon brown coal, 3 to 5 parts of water, 1 to 2 parts of talc and 1 to 5 per cent of glycerine or glycol; (4) 1 part of fish oil, 5 to 8 parts of water and ½ to 1 per cent of calcined magnesia. Sulphonated castor oil may be used as a protective colloid. The provisional specification also states that the insoluble mineral solid may be dispensed with, and gives further examples. (Br. Pat. 185,779. Plauson's, Ltd., London. Nov. 8, 1922.)

Formaldehyde Condensation Products—Turbid materials, resembling meerschaum and porcelain, are produced by condensing urea with not more than 120 per cent of formaldehyde in the presence of at least 3 per cent of acid, the proportions being calculated on the pure anhydrous material in each case. The products are easily worked, and being porous, may be impregnated with coloring solutions, oils, resins, salt solutions, etc. Examples are given in which urea is dissolved in formaldehyde solution, the solution heated to effervescence, nitric, sulphuric or hydrochloric acid then added, and the whole finally emptied into molds. (Br. Pat. 187,605; not yet accepted. H. Goldschmidt and O. Neuss, Berlin. Dec. 13, 1922.)

German Patents

For complete specifications of any German patent apply to the German Patent Office, 97 Gitschinerstrasse, Berlin, Germany.

Recovery of Sulphur—Hot inert gases, such as the products of combustion of producer gas, are passed through a mass containing S—e.g., spent gas-purifying material—and the issuing stream of gas is cooled to a point above the melting point of sulphur, whereby liquid sulphur is deposited. A portion of the gas is subsequently withdrawn and the remainder is mixed with a fresh supply of hot gas and again passed through the material, or a portion of the gas may be circulated repeatedly through the mass before it is cooled. (Ger. Pat. 357,033. Badische Anilin u. Soda Fabrik.)

Solution for Use in Drawing Iron and Steel Wire—(*A*) A slightly acid solution of $CuSO_4$ is mixed with one or more chlorides—e.g., NaCl or $FeCl_3$. The iron or steel wire is coated with copper by immersion in this solution, and after drawing, the copper coating is removed by treatment with an ammoniacal solution of copper sulphate. By using the mixture of salts copper separates more easily than from copper sulphate alone, and the copper adheres better to the wire, so that a thinner coating can be used than hitherto.

(*B*) The medium consists of two or more suitable chlorides, including preferably $FeCl_3$, with the addition of sufficient ammonia to produce a certain quantity of colloidal $Fe_2(OH)_6$. By the addition of ammonia the solution adheres better to the wire and its lubricating action is increased. The composition of the solution remains unchanged and the wire keeps clean till the end. When the solution is to be used for pickling the ammonia is omitted. (Ger. Pats. 299,031 (*A*) and 299,032 (*B*). O. Vogel.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields
Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

American Association for Advancement of Science Holds Annual Meeting in Boston

The Chemistry Section Holds Symposiums on Photosynthesis, Ionization and Separation of Isotopes

Sections Concerned With Engineering and Social Sciences Stress Place of Engineer in Civilization

ABOUT twenty-five hundred registered at the various conferences at the seventy-sixth meeting of the American Association for the Advancement of Science at Boston during the week Dec. 26 to 30. The meeting was noteworthy in several respects. In the first place, it showed an increasing disposition on the part of research men to pause in their labors and take account of stock. Many of the papers presented indicated a growing feeling that an investigator who gives the best that is in him to the search for truth can no longer content himself with the publication of his results and then rest secure in the conviction that the world will make a suitable use of his findings.

The recent outcroppings of medieval intolerance in various parts of the country, which have found their most prominent spokesman in William J. Bryan, are not to be lightly dismissed. They represent a well-financed and well-organized conspiracy to poison the spring of free scientific inquiry at its source and to dictate to students of science what shall be "truth" for educational purposes. The association as a whole therefore went on record in the most unequivocal way as to the scientific position of the biological theory of evolution in particular and the necessity of each man's drawing "the thing as he sees it, for the good of things as they are."

Proper Publicity Needed

It is recognized, however, that mere reaffirmation of fundamental truisms by a body of scientific men can have little effect as long as the message, spirit and content of science never reach a public which is constantly assailed by the clamor of fools and rogues. Science as it is must somehow "get across" to the great majority, and not remain buried in the dust of technicalities or appear travestied by the marvel mongers of the Sunday supplements.

There is needed a new and more

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ENGINEERING was represented at the meeting of the American Association for the Advancement of Science in two of the sections, Section K (Social and Economic Sciences), of which Dr. Henry S. Graves, of the Yale Forestry School, Yale University, is vice-president and chairman, and Section M (Engineering), F. M. Feiker, of the McGraw-Hill Co., Inc., New York, vice-president and chairman.

The keynote of the joint session between Section M and Section K was "The Relation of the Engineer to Conservation." John T. Black, State Health Commissioner, Hartford, Conn., presented a paper on conservation and industrial waste; William S. Murray, of New York City, spoke on the conservation of power.

Place of the Engineer

The keynote of the afternoon meeting of Section M was "The Place of the Engineer in Civilization," the principal paper being presented by Ira N. Hollis, president of the Worcester Polytechnic Institute. Dr. Hollis pointed out that from the dawn of history the emphasis has been placed upon the man who produces and the root names for producer in several of the earlier languages are synonymous with our definition of the term engineer. One phase or another of engineering activity enters into practically all the other arts and sciences. Dr. Hollis instanced the factor of transportation and communication as one vitally touching life and activities of men in all walks of life, and pointed out the engineer's place in the further development of transportation and communication systems in the world. Dr. J. B. Tyrrell, retiring vice-president of the section, in an address on "The Growth of the Mining Industry in Canada," pointed out the part that steam railway transportation played in the development of the mining industry as a practical illustration of the engineer's place in utilizing our natural resources.

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Metric Association Marks Progress at Boston Meeting

Wider Adoption of Metric System Reported—Opposition Is Expressed From Army and Navy

Substantial progress toward the wider adoption of the metric system in America was emphasized Dec. 30 at the annual meeting of the American Metric Association, held in connection with the convention in the same city of the American Association for the Advancement of Science. Well-attended sessions at the Massachusetts Institute of Technology and a dinner at the Copley-Plaza Hotel featured the program. Dr. George S. Kunz of New York presided, and interest was increased at the meeting by the appearance of opponents, who spoke on behalf of the Secretary of War, the United States Navy and industrial organizations.

During its convention, the American Association for the Advancement of Science reaffirmed its belief in the metric system, and passed a resolution recommending the use of metric units by scientific men in all papers of a professional character, with non-metric units in parentheses. This expression of opinion was most gratifying to advocates of the metric system. The association voted to shorten its name to the Metric Association; approved the adoption of the liter as the measure of capacity between the British Commonwealth and the United States, and passed a resolution favoring the compulsory metric system bill now before the Senate.

Advantages of Adoption Stressed

Among the speakers who carried out the advantages of the universal adoption of the metric system were A. E. Kennelly, of Cambridge, Mass., who emphasized the value of common units in applied science in an address upon "The Metric System in Electrical Engineering." B. L. Newkirk, of the General Electric Co., in a paper on "The Metric System in the Electrical Industry," reviewed the growth of metric measurements in the past century and pointed out that there is no hope of getting the non-English speaking world to adopt non-metric units. "If the world is to get together at all, it must be on a metric basis," he said.

Captain Elliott Snow, of the Con-

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Harding Approves the Three-Shift Day

President Pleased That Engineers Agree With Social Workers in Working Hour Program

The 12-hour day and the type of worker it produces have outlived their usefulness in American life, President Harding declares, commenting on the report of the committee on work-periods in continuous industry of the Federated American Engineering Societies.

This committee, after 2 years of investigation of more than forty continuous industries, including steel and iron, found that the 12-hour day was not an economic necessity. These findings, President Harding says, represent his "social viewpoint."

The President's statement, which will be embodied in the report now being compiled by the engineers, was given out in New York by the chairman of the committee, H. E. Howe of the National Research Council, Washington. It follows:

> It is a matter of very much gratification to me that the Federated American Engineering Societies, our foremost organization of American industrial skill, should have given 2 years of diligent inquiry, under competent experts, to a subject which is of very deep interest to me and important to the country.
>
> I rejoice to note the conclusions of this great body of experts are identical with those which I have reached from a purely social viewpoint. It has seemed to me a long time that the 12-hour day and the type of worker it produces have outlived their usefulness and their part in American life in the interests of good citizenship, of good business and of economic stability. The old order of the 12-hour day must give way to a better and wiser form of organization of the productive forces of the nation, so that proper family life and citizenship may be enjoyed suitably by all of our people.
>
> This clear and convincing report of the engineers must prove exceedingly helpful in showing that this much-to-be-desired result can be achieved without either economic or financial disturbance to the progress of American industry.

Members of the committee on work-periods, in addition to Chairman Howe, were J. Parke Channing, L. P. Alford, Fred J. Miller and Dwight T. Farnham of New York; Morris L. Cooke of Philadelphia, and L. W. Wallace of Washington. The field work was directed by Horace B. Drury of Washington, former member of the faculty of Ohio State University, and Bradley Stoughton of New York, chairman of the iron and steel committee of the American Institute of Mining and Metallurgical Engineers.

President Harding's declaration follows that of John D. Rockefeller, Jr., who in a recent statement favored the 8-hour day.

Standard Oil Co. Will Offer Technical Training to Employees

The Standard Oil Co. of California will soon inaugurate a correspondence course of instruction for employees in all parts of the state, designed to fit the students for better positions of technical character. The taking of the course is optional with the employees.

Nine Standard Formulas for Fertilizers Adopted by New England States

Reduction of the variety of mixed fertilizers which are to be offered for sale in the New England states to nine high analyses was agreed upon at a conference in Boston, Dec. 30, between agronomists representing the six states and representatives of manufacturers.

Analyses agreed upon as standard for New England are: 0-12-6, 2-12-4, 3-10-4, 3-10-6, 4-8-4, 4-8-6, 5-4-5, 5-8-7, 8-6-6.

The soil officials of the state colleges and experiment stations present agreed to recommend these analyses to the farmers of their states and the manufacturers agreed to push them, through their salesmen, above other analyses, although any of the present grades now being sold will be supplied upon request.

The New England meeting was the second at which state officials and fertilizer manufacturers have reached agreements to push high-analysis mixed fertilizers to the exclusion of a multiplicity of poorer grades, the first agreement having been reached at Chicago and affecting five of the Middle Western states. The present average tonnage of mixed fertilizer consumed annually in New England is about 130,000. Manufacturers representing 98 per cent of the tonnage sold in that section attended the Boston meeting, as did representatives of the soil improvement committee of the National Fertilizer Association.

A similar meeting is being arranged for the Middle Atlantic states, which are heavy consumers of fertilizer, to be held at an early date.

Large New Laboratory Dedicated at Stockholm College

New buildings and laboratories, constituting a department for chemical instruction which in size and equipment is second only to that of the largest American institutions, have just been opened by the Technical College in Stockholm, the ceremony of dedication being performed by the King of Sweden in the presence of a large assembly of prominent educators and men of affairs.

The chemical department at the Technical College now includes four laboraries, devoted respectively to research and instruction in organic chemistry, inorganic chemistry, technical chemistry, and electrochemical processes. There is also a laboratory for the study of fermentation. "The electrochemical industry is now of tremendous importance," said Prof. W. Palmaer, head of the department, in a speech at the opening exercises, "utilizing, as it does, the vast amount of power generated by the Swedish hydro-electric stations in the commercial production of a great variety of chemical and metallurgical products."

Memorials and congratulation were received from many educational institutions in neighboring countries.

Labor Shortage Discussed by A.I.M.E.

Desirability of Modification of Immigration Laws Discussed at New York Meeting

Establishment of a federal commission to study the nation's labor needs and recommend necessary changes in the present 3 per cent immigration law as a means of meeting the problem of a labor shortage was urged by Daniel Bloomfield, an industrial engineer of Boston, in an address before the Metropolitan section of the American Institute of Mining and Metallurgical Engineers at Rumford Hall, Jan. 3.

Mr. Bloomfield said that "taking down the bars of immigration without some definite, carefully devised program will not do."

"We must have a sound program," he said, "based on facts and dealing with the immigration on the basis of needs in order to help the situation." Mr. Bloomfield suggested that employees could help the situation by reducing the labor turnover, to make employment more regular in seasonal industries.

Federal Commission Suggested

"The next step in meeting the problem if labor shortage is likely to become acute," he continued, "might be a federal commission made up of a representative of the Department of Labor, Department of Commerce, representatives of employers, employees and the public groups to make a thorough study of the facts in the situaaion. If the facts then warrant action, Congress might modify the contract labor clause of the immigration law so as to permit this commission to bring in the type of laborers where work for them is guaranteed and for the period guaranteed by the concerns that need such labor. Such a commission, working with the immigration department, would act as a clearing house for labor and could so allocate labor that it would meet our needs. The per centum law might remain, but this commission could be given certain leeway in opening up or shutting down on the labor supply from abroad."

W. R. Ingalls, consulting engineer, said that he was not convinced that there was need of modifying the present immigration laws.

Countervailing Duties on Canadian Products Rescinded

The Treasury Department has revoked its orders directing imposition of customs duties on chloride of lime, calcium nitrate and cyanamide when imported from Canada. After the orders had been issued, close examination of the new tariff act disclosed that the retaliatory proviso of the calcium paragraph of the free list specifies only calcium acetate. The countervailing duty ordered on imports of this product from Canada stands and the others are rescinded.

New York Chemists Honor Pasteur

Joint Meeting of Metropolitan Sections Hears History of Great Scientist's Work and Modern Achievements That Grew from It

CHEMISTS of the metropolitan district gathered in Rumford Hall on Jan. 5, at a joint meeting of the New York Section of the American Chemical Society and of the Société de Chimie Industrielle, to commemorate the centenary of the birth of Louis Pasteur. Prof. Gary N. Calkins, of Columbia University, read a splendid paper on "Pasteur and the Science of Fermentation," and Prof. John N. Nelson, of Columbia University, spoke on "Pasteur and Chemical Asymmetry."

"No one science can claim Pasteur's genius," said Professor Calkins. Today the greatest expression of his genius is seen in his mastery of the method of science, particularly in medicine. Although he was not a physician or a biologist, by sheer ability to apply scientific methods he came to be recognized as a master in both sciences. Wherever he went, Pasteur was an initiator.

His Work on Fermentation

Pasteur's revolutionary work on fermentation was initiated by a Lille manufacturer of alcohol who came to Pasteur for advice on his process. At that time the ideas on fermentation were confused and hazy. The ordinary conception of the mechanism of fermentation as advanced by Liebig was entirely physical and did not recognize the essential part played in the process by living organisms. Pasteur first showed definitely that different activities of similar natures are brought about by living organisms and that different kinds of actions are caused by different species of bacteria. He saw the part played by micro-organisms in putrefaction. And he first conceived the life cycle and the part played by micro-organisms in putrefaction, the decay of living matter to ammonia, carbon dioxide, etc., in which form it is observed on plants by photosynthesis and again assimilated as food by living animals. The question naturally arose, Whence come these organisms? Up until the seventeenth century there was a very general belief in spontaneous generation. It was commonly accepted that lizards, flies, salamanders, etc., were generated spontaneously. Pasteur, with his characteristic, scientific thoroughness, experimented with sterile mediums instead of containers in contact with sterile air, and found that under such conditions no bacterial action was possible. His experiments demonstrated that the micro-organisms exist in the air, although for some time this theory was scoffed at and one of the proponents of the theory of spontaneous generation even went so far as to scout Pasteur's theory with the statement, "The air thus peopled would have the density of iron."

In 1865 Pasteur was called upon to study an epidemic which was causing havoc among the silk worms in the southern part of France, where the silk industry had already become a very flourishing business. In the six years that he was studying this problem he came to the conclusion that human diseases are caused by micro-organisms, in the same way that the disease was carried by the silk worm. This was really the beginning of Pasteur's far-reaching experiments on human diseases and the modern science of bacteriology.

Early Work on Chemical Asymmetry

Professor Nelson described Pasteur's early work on chemical asymmetry, which was done while he was a student at the Ecole Normale. At this time the first glimpse of chemical asymmetry had been obtained by Sir John Hershel, who pointed out that there are two varieties of quartz, one variety being, as it is called today, dextro-rotatory and the other laevo-rotatory. Certain organic substances were also known to be optically active. Pasteur conducted a number of experiments on tartaric acid and its salts. He came to the conclusion that the optical activity of tartrates was due to hemihedral crystals and that the difference between tartaric and racemic acids which had the same composition, properties, number of atoms and identical arrangement was simply in the different action on polarized light, which was due to the asymmetric arrangement of the crystal with the two substances. He also came to the conclusion that chemical asymmetry is caused solely by life forces. This conclusion has since been discredited, but nevertheless it was important because it was the origin of the present-day conception of fermentation. He also concluded that the asymmetry of two reactive bodies affects the properties of the resulting substance, a conclusion which is still tenable in the light of present knowledge.

This work extended from the year 1844 to 1860. It was important and far reaching enough in its consequences to constitute a commendable life work for the average man, but at its conclusion Pasteur stood only at the threshold of his career.

Selective Bacteriostatic Properties of Certain Dyes

The most interesting paper of the evening was delivered by Dr. John W. Churchman, of Cornell University Medical School, who spoke on "The Selective Bacteriostatic Properties of Certain Dyes." This was an especially timely subject in view of the fact that it represents a modern achievement in the field in which Pasteur was a pioneer. Chemical selection is one of the most interesting and one of the most mysterious phenomena of science. Some diseases affect only one race of human beings. Some diseases affect only one organ of the body. Lead palsy paralyzes all the numerous muscles in the wrist except one, which is apparently unaffected. Cocaine affects only the sensory nerves.

Ehrlich discovered that methylene blue injected in the blood stream picked out the nerve cells and maimed them, whereas it did not affect any other cells of the body.

A Scandanavian bacteriologist, Gramm, described the system of classification of bacteria which depends upon the staining action of gentian violet. The bacteria are stained with this dye, fixed with iodine, and then washed with alcohol. Some species of bacteria give up the color on this treatment and they are known as Gramm negative. Those which retain the stain are called Gramm positive. It has been found that the Gramm positive organisms are killed by stains, whereas the Gramm negative bacteria are not.

Dr. Churchman exhibited a number of flies which showed very conclusively that gentian violet exhibits highly selective properties in inhibiting the growth of certain species of bacteria. By the application of this principle it is possible to develop two strains of bacteria—those upon which gentian violet has a bacteriostatic action, and those which it does not affect. Sulphanilic acid, acid fuchsin, ethyl sulphonic acid also act selectively, but in exactly the opposite way.

Chemical Salesmen's Association Begins Lecture Course

Forty-six members of the Salesmen's Association of the American Chemical Industry turned out for the first lecture in Dr. F. E. Breithut's course in chemistry for salesmen at the City College of New York, Jan. 4. Dr. Breithut spoke on the subject of "How the Chemist Works" and it was a most interesting and comprehensive lecture. He explained, in non-technical terms, the functions of common laboratory equipment and gave a good idea of the chemist's technique.

Fifty-three members of the association have enrolled for the course, and others are expected to sign up before the next lecture. The members of the course include representatives of the following firms: American Cyanamid, Noil Chemical Co., Industrial Chemical Co., Marietta Refining Co., Peerless Color Co., Mathieson Alkali, Dow Chemical Co., Warner Chemical Co., B. J. Seydel Manufacturing Co., Edward Hill's Son Co., Roessler & Hasslacher, Marx & Rawolle, E. Fougera & Co., and the Mallinkrodt Chemical Co. Lectures will be given every Friday evening at C.C.N.Y. for 12 weeks.

Cash prizes have been offered by Williams Haynes for the three best essays by members of the course, on "The Value of Chemical Knowledge to Salesmen." The essays will be judged by a committee composed of F. E. Breithut, J. W. Boyer and D. H. Killeffer.

American Association for Advancement of Science

Chemistry Section Symposium

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effective mechanism of publicity; a means by which the scientific temper of the progressive thought of the world today may somehow be made a part of the working mental equipment of the "average newspaper reader." A great beginning in this respect has been made by the establishment of "Science Service," a sort of Associated News for science, with offices at Washington, D. C., under the experienced guidance of Dr. E. E. Slosson, sometime editor of the *Independent* and author, among other things, of "Creative Chemistry."

Symposium on Photosynthesis

Not content with his publicity work alone, Dr. Slosson gave one of the most interesting of the general papers presented, speaking at the symposium on photosynthesis. This was an attempt at an exhaustive inventory of possible sources of mechanical power. Besides the usual indirect utilization of solar energy by means of winds, tides, waves, water power and the storage of rainfall, the exploitation of fuels, etc., Dr. Slosson spoke of the possibilities of tapping the internal heat of the earth, the internal energy of atoms, dodging the second law of thermodynamics by sorting out fast molecules from slow ones, the use of photoelectric cells, and the exploitation of differences of temperature whether spatial (on the surface of the earth) or temporal, as between summer and winter. These and many other possibilities were passed in rapid review and formed an interesting introduction to the other papers on photosynthesis.

Dr. Spoehr, of the Carnegie Institution, was erudite and exhaustive. He left the listener crushed with the complexity of the photosynthetic problem and reported the failure of a long series of attempts to duplicate E. C. C. Baly's reported synthesis of formaldehyde from CO_2 and H_2O in ultra-violet light. Dr. Bovie, of the Haward Medical School, gave an entertaining but somewhat sketchy account of his own speculations in the field, enlivened by slides of hypothetical atomic structures and intersecting force fields, ending with a diagram showing the "hungry" amino-acid molecules inside a chloroplastid, attaching their polar groups to wandering molecules of H_2CO_3 in the plastid membrane. The carbonic complexes then rolled themselves up into rings and formed sugars.

S. E. Shepperd, of the Eastman Kodak Co., ended the discussion in a somewhat more hopeful vein. He first pointed out that interest in photochemistry is on the increase, due to the recent technical development of powerful sources of ultra-violet light, such as mercury vapor arcs in fused quartz, white flame carbon arcs and condensed spark discharges. These have enabled the efficiencies of many commercially promising processes to be studied in a comparative way and the validity of Einstein's law of photochemical equivalence has been confirmed in general, when the case is not complicated by side reactions. The outstanding commercial problem is to find new photochemical catalysts which, like chlorophyl, will take the relatively long wave length radiation in sunlight and hand it over to the chemical system in the form of the shorter wave length the system needs in order to become reactive.

Electrolytic Dissociation

Besides this session, many others contained papers of chemical interest. The discussion was most active in the session on ionization, in which D. A. McInness of M.I.T. ably presented the case for the complete dissociation of strong electrolytes which is based on the undoubted chance in the mobilities of the ions with concentration as shown by transference experiments. C. A. Kraus of Clark University and E. W. Washburn defended the opposite viewpoint and it seemed clear that the case is not fully settled, although the naïve view that the degree of dissociation of an electrolyte is always given by the ratio of the conductivity to the conductivity at infinite dilution must certainly be relinquished.

F. G. Cottrell showed slides of the Fixed Nitrogen Research Laboratory and outlined its work. Dr. Washburn described the new International Critical Tables of Physical Constants which are in preparation. These will be more complete than anything of the kind previously done and will include commercial materials as well as pure substances.

Separation of Isotopes

Much interest was aroused by W. D. Harkins, of the University of Chicago, who gave a résumé of his publications of the last 6 years dealing with the isotopic complexity of the elements, the structure of atomic nuclei, etc. He also described the recent progress of his students in separating the elements into their isotopes on a large scale, showing some fair-sized samples of mercury which differed by as much as a tenth of a unit of an atomic weight.

S. A. Mulliken, also of Chicago, described his own success in separating mercury to about the same extent by evaporation and diffusion through filter paper.

T. W. Richards, of Harvard, brought forward a new and very plausible method of calculating the diameters of the ions in crystals based upon compressibility data and his theory of compressible atoms. Professor Kraus emphasized the importance of his view that typical metals and typical electrolytes are really fundamentally similar, the negative electrons of the metal taking the place of the negative ion of the salt.

Jacques Loeb, of the Rockefeller Institute, presented his interesting view that proteins are not colloids in the sense of being molecular aggregates, but merely large single amphoteric molecules that are essentially like ordinary acids and bases. Enthusiasm for this idea was widely expressed, but on the other hand, many opposing views were mentioned, so that discussion on the subject promises to continue for some time.

The chemists concluded the session with a smoker at the American House. Santa Claus distributed presents, the *Pathetic Weakly* showed movies of chemical events and Dr. Slosson gave one of his brilliant talks. J. F. Norris of M.I.T. was the presiding officer.

Election of Officers

Dr. Charles D. Walcott, secretary of the Smithsonian Institution of Washington, was elected president for the year 1923 at a meeting of the council. Dr. Walcott has been secretary of the Smithsonian Institution since 1907. From 1894 to 1907 he was director of the United States Geological Survey, and from 1902 to 1907 he was the first director of the Reclamation Service. He is president of the National Academy of Sciences, a member of the National Research Council and chairman of the National Advisory Committee for Aëronautics.

Vice-Presidents Selected

Ten vice-presidents were elected, each representing a section of the association:

For the Chemical Section, Prof. E. W. Washburn of the University of Illinois and vice-chairman of the National Research Council.

For the Botanical Section, Prof. C. J. Chamberlain of the University of Chicago.

For the Anthropological Section, Assistant Prof. E. A. Hooton of Harvard.

For the Section on Social and Economic Sciences, John F. Crowell, director of the World Market Institute of New York.

For the Mathematical Section, Prof. Harris Hancock of the University of Cincinnati.

For the Physical Section, Prof. W. F. G. Swann of the University of Minnesota.

For the Geological and Geographical Section, Dr. Nevin M. Fenneman of the United States Geological Survey.

For the Zoölogical Section, Prof. Edward L. Rice of Ohio Wesleyan University.

For the Psychological Section, Prof. Raymond Dodge of Wesleyan University, Middletown, Conn.

For the Agricultural Section, President Raymond A. Pearson of Iowa State College of Agricultural and Mechanical Arts.

Section Secretaries Chosen

Two secretaries of sections were elected, Prof. W. D. Harkins of the University of Chicago being chosen for the Chemical Section and Prof. R. J. Terry of Washington University, St. Louis, for the Anthropological Section.

American Association for Advancement of Science

Engineering and Social Science Sections

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Dr. Hollis, as well as Harrington Emerson, another speaker of the afternoon, pointed out the need of the engineer's analytical study of facts for the solution of present-day problems, and both emphasized the idea that indirectly the engineer, because of his control of the instruments of production, is deeply concerned with present-day civilization. The paper by Prof. C. F. Scott, of Yale University, president of the Society for the Promotion of Engineering Education, on "New Phases of Engineering Education," was presented in Dr. Scott's absence by Dr. Dugald C. Jackson. Professor Scott in his paper indicated that because engineering was coming to take such a large place in our modern life it was essential that the training of engineers be approached with a new viewpoint of the engineer's place in the community.

The several contributions emphasized that the next step in engineering is to relate the problems of the material advance in civilization to the human problems of civilization, and that the engineer has an opportunity for leadership in approaching these human problems which have grown out of his own contributions in increasing the perplexity of life if he will apply the logic of his thinking with the understanding that human problems are problems of emotion as well as of logic.

Pan-American Relations

In the evening Calvin W. Rice, secretary of the American Society of Mechanical Engineers, presented an illustrated address on the engineering and scientific developments of South America. Mr. Rice pointed out three definite opportunities for the immediate association of engineers between North and South America: First, the development of a common understanding of standards, the start of which was made very definitely at the international engineering congress held at Rio de Janiero; second, the development of an English-Spanish dictionary and glossary of engineering terminology, and third, the development of an interchange of thought between engineering societies of North and South America. In this connection, Mr. Rice stated, Verne L. Havens, editor of *Ingeniería Internacional*, had been made permanent secretary of the International Engineering Congress. He also recounted the personal contacts that had been established in the various government and engineering societies to bring about this more intimate engineering understanding between the two continents. Mr. Rice's lecture was illustrated with lantern slides showing engineering developments in South America.

Largest Memorial Fund to Honor Ramsay

The largest sum ever raised to honor a man of science has been contributed to the memorial for Sir William Ramsay. The amount of the fund is more than $500,000.

Former Premier Asquith of England was president of a committee which, in 1917, made an appeal for £100,000 to be devoted to a Ramsay memorial. Later the Prince of Wales became patron of the fund. The sum collected in cash is £57,645. It has been augmented by research fellowships instituted by various dominion and foreign governments, to the value of about £60,000.

The cash sum includes subscriptions from Great Britain and Ireland, America, Australia, Canada, Chile, China, Denmark, Spain, Holland, India, Italy, Japan, New Zealand, Norway, Straits Settlements, France, Greece, Switzerland and Portugal.

The money, according to a report in *Science*, will be devoted to the erection of a chemical laboratory at University College, London, and to founding the Ramsay memorial fellowships in chemical science for British students. Each fellowship is of the value £300.

Feldspar Colloquium Planned by American Ceramic Society

At the meeting of the American Ceramic Society in St. Louis, there was started a discussion on feldspars which aroused much interest; this discussion was focussed chiefly on milling problems, with only incidental reference to questions of quality and methods of determining quality. Judging from prevailing sentiment, the time is ripe to move on toward the formulation of specifications, and at the request of the officers of the whitewares division, the organization of a colloquium on the subject is being undertaken.

The purpose of specifications such as it is hoped to evolve is not to enable the consumer to get more for less money, but to establish and define various grades of feldspar. It is a problem of classification rather than specification. Classification may be made on the basis of the intended use, the chemical composition, mineralogical origin, physical properties, or any combination of these. The classification according to use is derived from the properties of the material, and the latter are the important values to define. Some of these properties are fixed by nature; thus the fusion point depends on the chemical composition and apparently also on the mineralogical origin of the rock. It is believed that the members of the society are in possession of the data needed, and they are urgently requested to contribute to the program to be presented at the forthcoming meeting.

All communications on this subject should be addressed to Edward Schramm, of the Onondaga Pottery Co., Syracuse, N. Y.

Metric Association Marks Progress

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struction Corps of the United States Navy, opposed the general adoption of the metric system in industry, emphasizing the difficulties which shipbuilding would face in such an event. Major L. A. Nicholson, of the U. S. Army, presented a letter from Secretary of War Weeks, which opposed the passage of a compulsory metric bill by Congress, chiefly on the ground that it would cost about $3,500,000 to change existing war material in linear dimensions, and the same amount to change angular dimensions to a metric basis. Secretary Weeks declared that the forced adoption of the metric system would adversely affect both the supply of material and the industrial draft for war purposes.

E. A. Marsh, consulting superintendent of the Waltham Watch Co., and T. H. Miller, of the DeLaval Separator Co., reviewed the successful use of the metric system in their plants. Edward Richards, of New York, discussed the advantages of the metric system in forestry and lumber measurements, claiming that with the metric system more accurate sizing of lumber to meet future computations of strength of material in houses and other building would result.

F. H. Chase, of Boston, gave a talk upon the literature of weights and measures at the Boston Public Library during the afternoon, and this was followed by an inspection trip. The dinner at the Copley-Plaza was informal, and among the speakers were Dr. A. E. Kennelly, Dr. Hoffman, of the Babson Organization; Prof. R. A. Fessenden, of Boston; Captain Snow; Robert Spurr Weston, of Boston; Walter Wood, of Philadelphia; F. L. Roberts and B. L. Newkirk.

Election of Officers

Dr. Kunz was re-elected president of the association, the vice-presidents being A. E. Kennelly, T. H. Miller and W. J. Schiefflin. Howard Richards was re-elected secretary, and F. L. Roberts treasurer, with headquarters at 156 Fifth Ave., New York City. The publication of a monthly bulletin and the formation of a Metric League were proposed at the dinner, and will probably be carried forward soon.

Canadian Paper Mills Increase Operations

The announcement is made of a new pulp and paper mill to be erected at Kaslo, B. C., Canada, by Howland & Waltz of Minneapolis, who at present operate a sawmill at Kaslo and have big timber limits there. In addition to the large body of standing timber which they control, there is plenty of water power available for hydro-electric purposes.

Preparations are also being made to reopen the Whalen Pulp & Paper Co.'s pulp mill at Swanson Bay.

Difficult to Find Successor to Stratton at Bureau of Standards

No progress has been made in the search for a director for the Bureau of Standards to succeed S. W. Stratton, who retired from the government service to accept the presidency of the Massachusetts Institute of Technology. Due to the fact that industry is making much more extensive use of research laboratories, physicists, according to Commerce Secretary Hoover, are very scarce. As a result the level of salaries has risen greatly. Where physicists formerly commanded salaries ranging from $3,500 to $5,000, many of them now are being paid from $10,000 to $20,000, Secretary Hoover says. This, he declares, makes it very difficult for the government to find an ideal man for this place when it requires a physicist in the front rank of his profession, willing to work for $6,000.

Exhaustive Study of Carboy Problems Concluded by Trade Association

A final report has been submitted by the carboy test committee to the executive committee of the Manufacturing Chemists' Association. The recommendations, which will not be made public until after the report has been considered by the executive committee, probably will be embodied in the regulations governing the shipment of carboys.

Under the direction of Guy E. Carleton, the committee has made by far the most exhaustive tests of carboys ever attempted. They cover the physical properties of the container, the closures, the package surrounding the carboy and the recovery of broken and chipped carboys. Drop, swing and concussion tests were pursued exhaustively. Shocks were carefully calculated. Observers traveled in box cars loaded with carboys to note their behavior under the conditions of actual transportation.

Physical Chemistry Symposium Planned Under Svedberg

The Rochester section of the American Chemical Society has been very fortunate in securing Prof. Thé Svedberg, University of Upsala, Sweden, to act as presiding officer of a symposium on physical chemistry which will be held in Rochester on Friday and Saturday, Jan. 19 and 20.

Papers will be presented at this symposium by prominent physical chemists from Schenectady, Cornell, Syracuse, Buffalo and Rochester. Practically every phase of physical chemistry will be considered, with the exception of colloids. On this phase there will be no papers, since a colloid symposium will be held at the University of Wisconsin later in the year.

The Rochester section extends a personal invitation to anyone interested in this physical chemistry symposium to be present and take part either in the presentation of papers or in the discussion which will follow the papers.

Department of Commerce Hopes to Collect Dye Import Figures

Itemization of dye imports is under active consideration at the Department of Commerce. If money can be found with which to undertake this work, these figures will be made available to all interested through the usual publicity channels of the department.

Chilean Nitrate for Sale

Bids for 28,000 short tons of sodium nitrate will be received by the Ordnance Salvage Board, Army Building, 35 Whitehall St., New York, until noon, Jan. 30. The material is in storage at the Old Hickory Powder plant at Jacksonville, Tenn. Purchases of 100 tons or more may be made.

Personal

Dr. M. S. BENJAMIN, professor of agricultural chemistry in the Hawkesbury Argricultural College, Richmond, New South Wales, Australia, recently paid a visit to the chemical laboratories maintained by the government in Washington.

Captain J. L. BROWN, who during the war was ordnance inspector of the powder plant of the Hercules Co. at Dover, N. J., is now representative of the New Jersey State Department of Sanitary Engineering, with headquarters at Newark.

Dr. CALVIN ADAM BUEHLER of the Ohio State University has been appointed assistant professor of chemistry in the University of Tennessee, Knoxville, Tenn.

CURTIS R. BURNETT, an official of the American Oil & Supply Co., Newark, N. J., has been re-elected president of the Ironbound Manufacturers' Association, composed of industrial interests in the Ironbound section of the city.

Dr. GUSTAV EGLOFF, director of research at the Universal Oil Products Co. of Chicago, is spending a week in New York and Philadelphia in connection with that company's business.

W. R. INGALLS of New York, DANIEL BLOOMFIELD of Bloomfield & Bloomfield, Boston, and B. F. TILLSON of the New Jersey Zinc Co. were the principal speakers at a discussion of the general subject of immigration at a meeting of the New York Section of the A.I.M.E. held at the Chemists' Club, Jan. 3, 1923.

ARTHUR LAZARUS has resigned as chief of the cost accounting bureau of the Chamber of Commerce of the United States, to resume professional practice, with offices in Washington and New York.

Dr. JUAN DE LA CRUZ POSADO, an engineer of Colombia, is spending several weeks in New York City and vicinity in the interest of a number of South American industrial enterprises. He expects to return to Colombia late in January.

OLIVER C. RALSTON, superintendent of the Pacific Experiment Station of the U. S. Bureau of Mines, at Berkeley, Calif., recently addressed the California Section of the American Chemical Society. His subject was "Aluminum Chloride, Its Manufacture and Uses."

E. E. THUM, associate editor of *Chem. & Met.*, recently addressed chapters of the American Society for Steel Treating at Worcester, Springfield, Hartford and Philadelphia, speaking on the subject, "Educating the Metallurgist and the Management." During February he will speak before other chapters at Pittsburgh, Cincinnati and South Bend on a similar topic.

Prof. WALTER G. WHITMAN, formerly assistant professor of chemical engineering, has been appointed assistant director of the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology.

Obituary

WILLIAM R. WALKER died on Dec. 20. According to the *Iron Age* he was born at LaPorte, Ind., Nov. 26, 1857, and his career was closely identified with the iron and steel industry. His first employment was with the North Chicago Rolling Mill Co., Chicago; then he was appointed chemist for the Crown Point Iron Co., Crown Point, N. Y., and later he was with Spang, Chalfant & Co., Pittsburgh, as works superintendent. He was early associated with Robert Forsyth, the well-known steel works engineer, who constructed the South Chicago works of the North Chicago Rolling Mill Co. in the '80s. Prior to 1890 Mr. Walker was works manager of the Union works of the Illinois Steel Co., Chicago, and later became general manager of the South Chicago works for the same company.

At the time of the formation of the United States Steel Corporation in 1901 Mr. Walker was appointed assistant to the president, a position which he held at the time of his death. He gave special attention to metallurgical research and to improvements in operation and production. In the words of President James A. Farrell, "Mr. Walker was a man of keen mental attainments and possessed an exceptional knowledge of the iron and steel industry from both scientific and practical standpoints." Mr. Walker was a member of many technical associations and took a leading part in their activities. He was highly esteemed by his associates in the United States Steel Corporation and in the iron and steel industry.

Market Conditions

In Chemical, Metallurgical and Allied Industries

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities Prevailing Prices and Market Letters From Principal Industrial Centers

Recent Trend of Prices

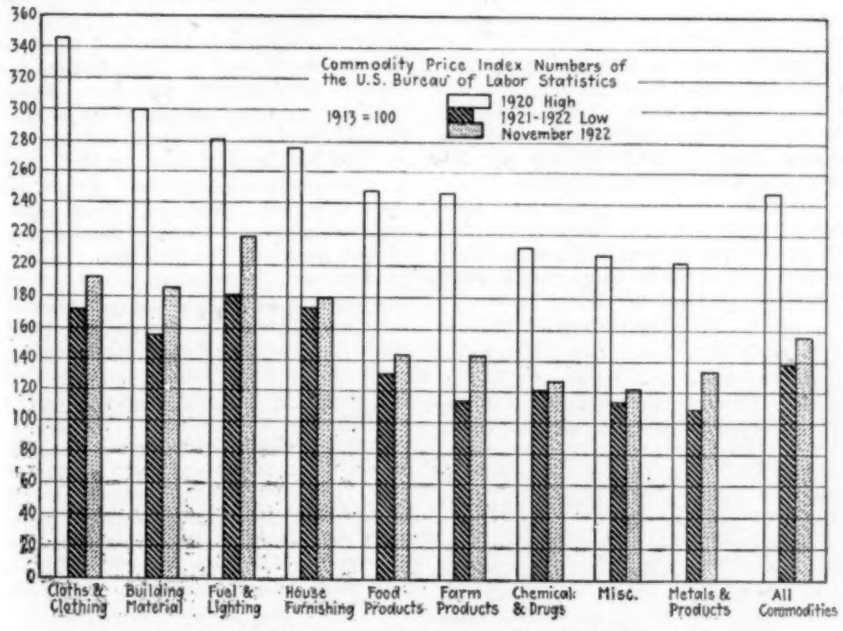
Uneven Recovery During 1922 Has Not Completely Corrected Past Disparities

A year ago it was complained that there was a maladjustment of prices, that disparities among the great groups of commodities seriously curtailed buying power, particularly of the farmer and the producer of certain raw materials. Today these conditions have been corrected to a certain extent, but there is still considerable evidence of distortion. The pronounced recovery of farm products has been beneficial, but the strikes in the mines and on the railroads have caused an altogether disproportionate rise in fuel prices. Furthermore, the record building boom of the past year has been accompanied by a marked stiffening of the prices for building materials.

TABLE I. CHANGES IN WHOLESALE PRICES IN 1922

Group	January, 1922	November, 1922	Net Gain
Building materials	157	185	28
Fuel and lighting	195	218	23
Metal and metal products	112	133	21
Farm products	122	143	21
Cloths and clothing	176	192	16
Food products	131	143	12
Miscellaneous	117	122	5
Chemicals and drugs	124	127	3
Housefurnishings	178	179	1
All commodities	138	156	18

Table I and the accompanying figure show the net changes that occurred during the first 11 months of 1922. In both, prices in 1913 are taken as a basis of 100.



A COMPARISON OF WHOLESALE PRICES SINCE 1920

The Government Indexes

The "all commodities" index of the United States Bureau of Labor Statistics rose from 138 in January, 1922, to 156 in November, 1922, a gain of 18 points. During this period the index for building materials showed a net change of 28 points, fuel and lighting 23 points, and farm products 21 points. On the other hand, the groups headed Miscellaneous, Chemical and Drugs, and Housefurnishings showed much lower gains—namely, 5, 3 and 1, respectively.

Record Buying by the Railroads

Railroad purchasing is often regarded as an important index of general buying, and certainly it bears a very vital relationship to activity in the steel industry. It is significant, therefore, that in 1921 only 239 locomotives and 23,346 freight cars were bought by the railroads, while in the first 11 months of 1922 ten times as many locomotives and six times as many cars were purchased. The figures for 1922 are 2,175 locomotives and 139,257 freight cars, according to a recent compilation made in connection with a general survey by the Harvard Economic Service.

"Chem. & Met." Weighted Index of Chemical Prices

Base = 100 for 1913-14

This week	172.79
Last week	171.30
January, 1922	144
January, 1921	181
January, 1920	242
April, 1918 (high)	286
April, 1921 (low)	140

The continued strength of the cottonseed oil market was sufficient to offset slightly lower prices on ammonium sulphate and linseed oil. This index has shown a gain of almost 30 points during the past year.

Healthy Business Prospects in Heavy Chemicals

1923 Contracts Will Tax Capacity of Productive Equipment in Many Branches of the Industry

In general there are but few better indexes of business condition than is the heavy chemical industry. Products such as caustic soda, sulphuric acid and soda ash enter into practically every line of industrial activity. When it is stated, therefore, that 1923 holds prospects for "good, steady, healthy business" in heavy chemicals, it is safe to draw the inference that the nation's entire industrial life is in for a healthy improvement.

The president of the Mathieson Alkali Works, Inc., in an article appearing in the special chemical section of the *Journal of Commerce* (New York), is authority for the following statement:

> The heavy chemical industry has continued its work of eliminating speculative middlemen who became so prominent during the war period, with the result that violent fluctuations in heavy chemical prices have become almost a thing of the past.
>
> In the face of the increasing costs that began last fall, due to fuel, labor and freight rates, the larger companies of this industry apparently were willing to contribute their part toward the deflation of the industrial and commercial life of the country; consequently, when 1923 contracts were taken up, the larger manufacturers seemed to have attempted to maintain the prices of 1922 with few exceptions, where advances were absolutely necessary. It remains to be seen whether or not the purpose aimed at will work out in practice.
>
> The year 1923 should hold out a very encouraging outlook for a good steady, healthy business, provided business is not interfered with by attempted class legislation at Washington and attempts of certain classes to maintain their war wages, while wanting everything else reduced. Furthermore, it is our belief that the limit of the country's heavy chemical activities will not be that of plant capacities, but will be that measured by the supply of labor, which incidentally will probably be the experience of the entire industrial life of the country.

Chemical Prices at Higher Levels as Business Expands

Arsenic and Its Derivatives, Bleaching Powder and Copper Sulphate Feature Chemical Market—Acetate of Soda Makers Reduce Prices

MOST chemical prices in the New York market during the past week were well maintained and manufacturers were inclined to believe that expanding industrial activity during the year would serve to keep figures at fairly high levels. Arsenic still continued to head the list and material on spot remained in exceedingly light supply. Lead arsenate and calcium arsenate remained quite steady in sympathy with the arsenic situation. Trading in formaldehyde slackened considerably during the interval, but producers intimated the possibility of a new price advance, due to the steady rise in producing costs. Manufacturers of acetate of soda announced a reduction of ¾c. per lb. on material at the works, presumably in order to stimulate consuming interest. Producers of bleach reported a completely sold up market, with the demand far exceeding the supply.

Copper sulphate prices have remained very firm in producing quarters, in view of the fact that the metal has advanced considerably during the past few weeks, and there has been a steady demand by agricultural interests for contracts over the coming season. The alkali market for export remained quiet, although the domestic demand continued very strong. Prussiate of soda and barium chloride were somewhat easier in a very quiet market. Producers of salammoniac reported a steady contract call from the domestic trade. Oxalic acid remained practically unchanged at recent levels.

Principal Price Changes

Acetate of Soda—Leading producers announced a reduction, due to the weakened demand from the consumer. The general range is around 6¾@7c. per lb., f.o.b works.

Alcohol — Producers continued to quote former levels, but intimated an early increase on methanol. The 95 per cent grade is quoted at $1.23 per gal. and 97 per cent at $1.25.

Arsenic—Manufacturers are completely sold up at the works and are not eager to accept future orders. Export shipments have been coming in at a very slow rate from Japan and Germany and it is very doubtful if any recovery will be accomplished within the first quarter. Spot stocks were quoted at 16c. per lb., with future held at 15½c.

Barium Chloride—Importers reduced spot goods to $90@$95 per ton, depending upon quantity. Domestic producers reported a fair call from consumers and quoted carload lots at $95 per ton, f.o.b. works.

Bleaching Powder—This product is fast becoming one of the leading features of the market. It is quite certain that prices will be materially higher before the spring season, since manufacturers are completely sold up. In some instances deliveries cannot be made until the latter part of February. Contracts for carload lots, f.o.b. works, were heard around $2 per 100 lb., with odd spot at $2.30@$2.50 per 100 lb.

Formaldehyde — The demand has eased up somewhat, but prices were well sustained. Leading producers intimated another increase for the near future. Spot material was quoted at 16c. per lb., carload basis.

Lead Arsenate—Producers were very firm due to the scarcity of arsenic. Prices for limited stocks were heard around 21c. per lb.

Sal Ammoniac—Manufacturers were quite satisfied with the volume of contract business. Quotations among first hands ranged around 7½c. per lb. for the white granular and 7¾c. for the gray. Resale goods of imported quality were held at 6½c. per lb. for white and 8c. per lb. for gray.

Caustic Soda — Consuming interest continued along fairly active lines and prices ex-store were quoted at $3.75@$4 per 100 lb. Export demand was rather quiet at $3.50@$3.60 per 100 lb. f.a.s., for standard brands.

Prussiate of Soda—Importers have again reduced prices, owing to the lack of consuming interest. Spot material was quoted down to 18½c. per lb., with shipments around 18c.

Vegetable Oils

Linseed Oil—Demand has slackened somewhat and prices reflected this condition. Spot oil was quoted by leading refiners at 87c. per gal., carload basis, in barrels. January shipments held around 85c., with January-February at 84c. per gal. April shipments were quoted at 80c. per gal.

Cottonseed Oil—Prices continued to advance on the crude oil and during the next week 9¾c. per lb. for crude oil, f.o.b. mills, Southeast, was considered an inside price.

Chinawood Oil—The market during the past week was quite active. Quotations ranged around 14@14½c.

St. Louis Market Reflects Better Business Conditions

Chemical Prices Are Advanced and There Are Prospects for Further Increases in Many Lines

ST. LOUIS, MO., Jan. 1, 1923.

Prices have not weakened, but on the contrary have stiffened materially since our last report. Further important advances would not prove surprising, for the costs of production are advancing steadily. Prospects for the year are very bright and a feeling of optimism is prominent in all lines.

A slight firming up in the alkali market has been noticeable in this market during the last 2 weeks. No price changes of any note have taken place, but price shading and the mad scramble for business have been conspicuously absent. *Caustic soda* is being quoted at $4.25 per 100 lb. for the flake in 5-drum lots and $3.90 for the solid in like quantities. *Soda ash* is firm at $2.30 in bags and $2.40 in barrels in lots of five. *Sodium bicarbonate* has not changed in price for some time, and about the best that is being done is $2.40 per 100 lb. in 3- to 5-bbl. lots. *Sal soda* is firm at $1.65 per 100 lb. in 5-bbl. lots and has been holding this level for sometime.

Unusual Sulphuric Acid Demand

The heavy *mineral acid* market is in sound shape, surplus stocks having been diminished and the demand being unusually good. *Sulphuric acid* is leading the group and the demand this fall has been extraordinary. The *white arsenic* situation remains unchanged. There is still a very great scarcity of this material, and the only goods that seem to be available are the imported. The demand from the insecticide manufacturers is unusually heavy. There has been very little doing in *citric acid* during the past 2 weeks. *Carbon bisulphide, technical*, is rather slow, as this is the off season. The demand for *carbon tetrachloride* has been steady with a very firm market. The production of *copperas* has increased, but the demand has kept abreast so that there is practically no surplus. Prices remain firm and unchanged. Price quotations on *glycerine* remain the same as of our previous report—that is, 18½c. in drums. The market is not strong and dealers are expecting a decline in the near future. Contracts are being made on 3 months basis and 6 months basis with protection against decline, and in one or two instances a flat price of 18c. has been done on a 6-month contract without protection. *Sulphur* is slightly weaker and can be had at $1.90 per 100 lb. for commercial in bags. There is still a very broad movement in *zinc sulphate*, prices ruling at 3¾c. in carload lots and 3¾c.@4c. in less than carload lots, f.o.b. St. Louis.

Oils and Paint Materials

Linseed oil is holding very firm at $1@$1.02 per gal. in 1- to 4-bbl. lots, and 90@92c. in 5-bbl. lots or over. Future prices are firm due to unfavorable reports from the Argentine flaxseed fields. Not much contract business is being done at present. *Castor oil* is still holding at 13½c. in drums, with little prospect for any decline in the near future. *Turpentine* has slipped off slightly and is being quoted at 14c. in single barrels, $1.37 in 5-bbl. lots.

So far the expected rise in the *zinc oxide* price has not materialized, and the material is on a firm basis. A good volume of business is being done. No changes are reported for *whiting, blanc fixe* or *barytes*, but business is on the increase and manufacturers in this section report a waiting market.

A Seasonal Lull in the Chicago Market

A Good Outlook for the Year, However, Has Kept Prices at Fairly High Levels

CHICAGO, Ill., Jan. 5, 1923.

The chemical market has been very quiet for the past 2 weeks, with the industry reporting little business. Prices held firm, as it was obvious that it was not a question of price that was keeping the buyers out of the market. The outlook for this year is exceptionally fine, however, and all factors are expecting a prosperous year.

ALKALIS SELLING BELOW COST

The alkali market continued firm, with rumors of an advance to take place in the near future. Actual business was very light and spot quotations on *caustic soda* were unchanged at $3.50 per 100 lb. for the solid 76 per cent and $4.25 for the ground or flake. *Soda ash* was quiet and unchanged at $2.25 per 100 lb. for material in cooperage. *Caustic potash* moved only in a very small way at 7¼@7½c. per lb. for the 88-92 per cent material. Dealers claim that this price is lower than the present replacement cost.

Alums continued quiet and were unchanged in price. *Potash alum* in lump form was quoted at 4½@5c. per lb. and in powdered form at 5½@6c. *Sal ammoniac* was in a firm position, with spot supplies held at 8c. per lb. for the white granular. *Barium chloride* was unchanged in price, with the demand rather quiet. Prime white material was offered at $110 per ton. *Barium hydrate* was dull and supplies were available at 6¼c. per lb. in large casks. *White arsenic* continued very firm and was so scarce that a holder could get his own price. One or two small lots were offered at 17c. per lb. *Carbon tetrachloride* moved in a fair way and was very firm at 10½c. per lb. *Carbon bisulphide* was quoted in small or moderate lots for delivery from spot stock at 7½c. per lb.

OTHER PRICES WELL MAINTAINED

Copper sulphate was in rather limited request, but the price of 6c. per lb. was well maintained. *Formaldehyde* was firm at 17c. per lb. and supplies were reported as scanty. *Hexamethylenetetramine* was in fair request and supplies of foreign material were offered at 82@85c. per lb. *Furfural* was quoted at 25c. per lb. in thousand pound lots. *Glycerine* was more or less unsteady and while the quoted price for the c.p. material in drums was 18½c., it was possible that good-sized business would have been taken at 18c.

LINSEED OIL AND TURPENTINE

Linseed oil was not moving in a large way, but the price was well maintained. The boiled oil in single-barrel lots was quoted today at 92c. per gal.

Turpentine was still considered high priced and dealers reported very little moving. The pure spirits was quoted at the close of today's market at $1.54 per gal. in single-drum lots.

Steel Market Enters Year With Better Prospects

Most Mills Comfortably Booked Ahead at Fairly Satisfactory Prices

PITTSBURGH, Jan. 5, 1923.

The complexion of the steel market changed decidedly during December and the outlook for a continuance of good business in the steel industry improved materially. December may be said to have made an unusual record in one respect, in that the turnover, in actual orders, was greater in the second half of the month than in the first half.

Thus the steel market has entered the new year with considerable momentum and naturally the prospect is that the buying will continue in very fair volume. Mill order books are in such shape, however, that a decided lull for a month would make no particular difference in the general situation. A number of mills had at the beginning of December not enough business to carry their operations fully through the month. Now these same mills are fully booked for more than a month. Not a few are comfortably booked for the whole quarter, while the Steel Corporation is almost wholly sold up for a longer period.

OUTPUT AT 75 PER CENT CAPACITY

Steel production continues at approximately the rate of the last 3 months of the old year, ingots being made at about 40,000,000 gross tons a year, or at about 75 per cent of capacity, finished rolled steel production being at about 30,000,000 tons a year. Production seems likely to increase rather than decrease in the next 2 or 3 months. The 40,000,000-ton rate compares with actual production in the whole of 1922 of about 34,000,000 tons, 19,000,000 tons in 1921 and 30,000,000 tons in both 1912 and 1913, the two greatest tonnage years before the war.

COKE AND PIG IRON

The Connellsville coke market has eased off a trifle in the past week, due to a practical cessation of buying by Eastern distributors for domestic consumption. Furnace coke is quotable at $8.50 @$9 against $9@$9.50 a week ago. Foundry coke remains at $9@$9.50 and there is somewhat more buying, although the market is still rather sluggish. Prices mentioned are for spot or prompt shipment.

Pig iron has been quiet in the past week. Foundry iron remains at $27 valley, to which it advanced after furnaces had made good sales, early in December, at $25 for first quarter. Basic, which went in several cases recently at $24.25 valley, cannot be bought at under $25 now and $26 might have to be paid. The stiffening is due not to increased inquiry but to the fact that steel interests that were offering basic iron have less inclination to part with it as their own consumption prospects are improved. Bessemer remains quiet at $27.50 valley.

Billets, sheet bars and slabs are quotable at $36.50, Pittsburgh or Youngstown. Very little has been done in billets and slabs, but there has been a very fair volume of covering in sheet bars as sales of sheets have been made.

Bars, shapes and plates are practically firm at 2c., concessions from this level being much less common than a month or two ago. Some large consumers of bars, expecting a concession on first quarter supplies, are now forced to pay the full price. Mills are best booked in bars, shapes coming next, while plates are a poor third.

Hoops are quoted at a general level of 2.90c., but orders that are at all attractive seem to be going at 2.75c., except for the lighter gages. Hot-rolled strips are at substantially the same level as hoops. Cold-rolled strips are firm at 4.50c. There is a very fair demand for both hot- and cold-rolled strips, attributable largely to activity in the automobile industry.

PIPE MILLS ACTIVE

Pipe mills are under about as much pressure as formerly for deliveries of butt weld pipe. Jobbers' stocks are practically exhausted and mills have no stocks. It is not unusual for mills to have a stock equal to a month's production, and normal jobbers' stocks would probably represent a larger tonnage still. The continued heavy pressure for deliveries is due to the open winter. Should consumption decrease for a time on account of weather, the slack would easily be taken up by partial replenishment of stocks. The outlook is for heavy consumption this season in oil country goods, as it is practically certain there will be a fair amount of drilling, and there is occasion for laying quite a good deal of pipe line, particularly from the Wyoming field. Tubular goods prices are very firmly maintained, merchant steel pipe being at 66 per cent basing discount.

The market for sheets is firm at 2.50c. for blue annealed, 3.35c. for black, 4.35c. for galvanized and 4.70@5c. for automobile sheets, depending chiefly on time of delivery.

Tin plate buying has been rather brisk in the past few weeks, the business being chiefly in definite orders, with specifications, for January and February delivery or for delivery over the quarter. There has not been much contracting for the half year. The market is very firm, on the basis of $4.75 per base box for 100-lb. cokes. Predictions are practically universal that this year will break all records in domestic consumption of tin plate.

Bookings in wire products, particularly nails, have been increasing and all producers are sold up for comfortable distances ahead. The majority of independents have advanced their prices $2 a ton, not so much with the idea of obtaining higher prices at once, but of protecting their order books from getting too full and enabling them later to get the higher prices by way of a delivery premium. The leading interest is not expected to modify its prices, which are at 2.45c. for plain wire, $2.70 for wire nails and $2.20 for cement-coated nails.

Current Prices in the New York Market

FOR CHEMICALS, OILS AND ALLIED PRODUCTS

Although these prices are for the spot market in New York City, a special effort has been made to report the American manufacturer's quotations whenever available. In many instances these are for material f.o.b. works or on a contract basis and these prices are so designated. Quotations on imported and resale stocks are reported when of sufficient importance to have a material effect on the market. Prices quoted in these columns apply to large quantities in original packages.

General Chemicals

Acetic anhydride, 85%, drums	lb.	$0.39 – $0.41
Acetone, drums	lb.	.21 – .21½
Acid, acetic, 28%, bbl.	100 lb.	3.50 – 3.60
Acetic, 56%, bbl.	100 lb.	7.00 – 7.15
Glacial, 99½%, carboys	100 lb.	12.80 – 13.25
Boric, crystals, bbl.	lb.	.11½– .11¾
Boric, powder, bbl.	lb.	.11 – .11½
Citric, kegs	lb.	.49 – .50
Formic, 85%	lb.	.18 – .19
Gallic, tech.	lb.	.45 – .50
Hydrochloric, 18° tanks, 100	lb.	.80 – 1.00
Hydrofluoric, 52%, carboys	lb.	.11 – .11½
Lactic, 44%, tech., light, bbl.	lb.	.11 – .11½
22% tech., light, bbl.	lb.	.05 – .05½
Muriatic, 20°, tanks, 100	lb.	1.00 – 1.10
Nitric, 36°, carboys	lb.	.04½– .05
Nitric, 42°, carboys	lb.	.06 – .06½
Oleum, 20%, tanks	ton	17.00 – 18.00
Oxalic, crystals, bbl.	lb.	.13 – .13½
Phosphoric, 50% carboys	lb.	.07½– .08
Pyrogallic, resublimed	lb.	1.50 – 1.60
Sulphuric, 60°, tanks	ton	9.00 – 10.00
Sulphuric, 60°, drums	ton	12.00 – 14.00
Sulphuric, 66°, tanks	ton	14.50 – 15.00
Sulphuric, 66° drums	ton	19.00 – 20.00
Tannic, U.S.P., bbl.	lb.	.65 – .70
Tannic, tech., bbl.	lb.	.40 – .45
Tartaric, imp. crys., bbl.	lb.	.30½– .31
Tartaric, imp., powd., bbl.	lb.	.31 – .32
Tartaric, domestic, bbl.	lb.	.31 – .32
Tungstic, per lb. of WO	lb.	1.00 – 1.20
Alcohol, butyl, drums	gal.	.18 – .23
Alcohol ethyl (Cologne spirit), bbl.	gal.	4.75 – 4.95
Alcohol, methyl (see Methanol)		
Alcohol, denatured, 188 proof No. 1	gal.	.39 – .41
Alum, ammonia, lump, bbl.	lb.	.03½– .03¾
Potash, lump, bbl.	lb.	.03½– .03¾
Chrome, lump, potash, bbl.	lb.	.05 – .05½
Aluminum sulphate, com., bags	100 lb.	1.50 – 1.65
Iron free bags	lb.	.02½– .02¾
Aqua ammonia, 26°, drums	lb.	.06½– .07½
Ammonia, anhydrous, cyl.	lb.	.30 – .30½
Ammonium carbonate, powd. casks	lb.	.09 – .09½
Ammonium nitrate, tech., casks	lb.	.07½– .07¾
Amylacetate tech., drums	gal.	2.80 – 3.05
Arsenic, white, powd., bbl.	lb.	.15½– .16
Arsenic, red, powd., kegs	lb.	.13½– .14
Barium carbonate, bbl.	ton	75.00 – 77.00
Barium chloride, bbl.	ton	94.00 –100.00
Barium dioxide, drums	lb.	.18 – .18½
Barium nitrate, casks		.08½– .08¾
Barium sulphate, bbl.	lb.	.04 – .04½
Blanc fixe, dry, bbl.	lb.	.04 – .04½
Blanc fixe, pulp, bbl.	ton	45.00 – 55.00
Bleaching powder, f.o.b. wks., drums	100 lb.	2.00 – 2.50
Resale drums	100 lb.	2.25 – 2.50
Borax, bbl.	lb.	.05½– .05¾
Bromine, cases	lb.	.27 – .28
Calcium acetate, bags	100 lb.	3.50 – 3.60
Calcium carbide, drums	lb.	.04½– .04¾
Calcium chloride, fused, drums	ton	22.00 – 23.00
Gran. drums	lb.	.01½– .01¾
Calcium phosphate, mono, bbl.	lb.	.06½– .07
Camphor, cases	lb.	.95 – .96
Carbon bisulphide, drums	lb.	.07 – .07½
Carbon tetrachloride, drums	lb.	.10 – .10¼
Chalk, precip.—domestic, light, bbl.	lb.	.04½– .04¾
Domestic, heavy, bbl.	lb.	.03½– .03¾
Imported, light, bbl.	lb.	.04½– .05
Chlorine, liquid, cylinders	lb.	.06 – .06½
Chloroform, tech., drums	lb.	.35 – .38
Cobalt oxide, bbl.	lb.	2.10 – 2.25
Copperas, bulk, f.o.b. wks.	ton	20.00 – 22.00
Copper carbonate, bbl.	lb.	.20 – .20½
Copper cyanide, drums	lb.	.50 – .55
Copper sulphate, crys., bbl.	100 lb.	6.00 – 6.25
Cream of tartar, bbl.	lb.	.25 – .26
Dextrine, corn, bags	100 lb.	3.25 – 3.50
Epsom salt, dom., tech., bbl.	100 lb.	2.10 – 2.25
Epsom salt, imp., tech., bags	100 lb.	1.10 – 1.25
Epsom salt, U.S.P., dom., bbl.	100 lb.	2.50 – 2.75
Ether, U.S.P., drums	lb.	.13 – .15
Ethyl acetate, com., 85%, drums	gal.	.80 – .85
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	.95 – 1.00
Formaldehyde, 40%, bbl.	lb.	.16 – .16½
Fullers earth, f.o.b. mines	net ton	$16.00 –$17.00
Fullers earth—imp., powd., net	ton	30.00 – 32.00
Fusel oil, ref., drums	gal.	3.55 – 4.05
Fusel oil, crude, drums	gal.	2.30 – 2.40
Glaubers salt, wks., bags	100 lb.	1.20 – 1.40
Glaubers salt, imp., bags	100 lb.	1.00 – 1.25
Glycerine, c.p., drums extra	lb.	.18½– .19
Glycerine, dynamite, drums	lb.	.16 – .17
Iodine, resublimed	lb.	4.50 – 4.60
Iron oxide, red, casks	lb.	.12 – .18
Lead:		
White, basic cabonate, dry, casks	lb.	.08 – .08¾
White, in oil, kegs	lb.	.10¾– .12
Red, dry, casks	lb.	.10½– .10¾
Red, in oil, kegs	lb.	.12 – .14
Lead acetate, white crys., bbl.	lb.	.12 – .12½
Lead arsenate, powd., bbl.	lb.	.21 – .22
Litharge, comm., casks	lb.	.09½– .10
Lithophone, bbl.	lb.	.06½– .06¾
Magnesium carb., tech., bags	lb.	.07 – .07½
Methanol, 95%, bbl.	gal.	1.23 – 1.25
Methanol, 97%, bbl.	gal.	1.25 – 1.27
Nickel salt, double, bbl.	lb.	.10 – .10½
Nickel salts, single, bbl.	lb.	.11 – .11½
Phosgene		.60 – .75
Phosphorus, red, cases	lb.	.35 – .40
Phosphorus, yellow, cases	lb.	.30 – .35
Potassium bichromate, casks	lb.	.09½– .10
Potassium bromide, gran., bbl.	lb.	.18 – .25
Potassium carbonate, 80-85%, calcined, casks	lb.	.05½– .05¾
Potassium chlorate, powd.	lb.	.07½– .08
Potassium cyanide, drums	lb.	.47 – .80
Potassium hydroxide (caustic potash) drums	100 lb.	6.50 – 6.75
Potassium iodide, cases	lb.	3.55 – 3.65
Potassium nitrate, bbl.	lb.	.06½– .07
Potassium permanganate, drums	lb.	.16 – .16½
Potassium prussiate, red, casks	lb.	.90 – .95
Potassium prussiate, yellow, casks	lb.	.38 – .39
Salammoniac, white, gran., casks	lb.	.06½– .06¾
Gray, gran., casks	lb.	.08 – .08¼
Salsoda, bbl.	100 lb.	1.20 – 1.40
Salt cake (bulk)	ton	25.00 – 27.00
Soda ash, light, 58% flat, bags, contract	100 lb.	1.60 – 1.67
Soda ash, light, basis, 48%, bags, contract, f.o.b. wks.	100 lb.	1.20 – 1.30
Soda ash, light, 58%, flat, bags, resale	100 lb.	1.75 – 1.80
Soda ash, dense, bags, contract, basis 48%	100 lb.	1.17½– 1.20
Soda ash, dense, in bags, resale	100 lb.	1.85 – 1.90
Soda, caustic, 76%, solid, drums, f.a.s.	100 lb.	3.50 – 3.75
Soda, caustic, 76%, solid, drums, contract	100 lb.	3.35 – 3.40
Soda, caustic, basis 60% wks., contract	100 lb.	2.50 – 2.60
Soda, caustic, ground and flake, contracts	100 lb.	3.80 – 3.90
Soda, caustic, ground and flake, resale	100 lb.	4.00 – 4.15
Sodium acetate, works, bags	lb.	.06½– .07¼
Sodium bicarbonate, bbl.	100 lb.	1.75 – 1.85
Sodium bichromate, casks	lb.	.07½– .07¾
Sodium bisulphate (niter cake)	ton	6.00 – 7.00
Sodium bisulphite, powd., U.S.P., bbl.	lb.	.04½– .04¾
Sodium chlorate, kegs	lb.	.06 – .07
Sodium chloride	long ton	12.00 – 13.00
Sodium cyanide, cases	lb.	.19 – .23
Sodium fluoride, bbl.	lb.	.09 – .09½
Sodium hyposulphite, bbl.	lb.	.03 – .03½
Sodium nitrite, casks	lb.	.08¼– .09
Sodium peroxide, powd., cases	lb.	.28 – .30
Sodium phosphate, dibasic, bbl.	lb.	.03½– .04
Sodium prussiate, yel. drums	lb.	.18½– .20
Sodium silicate (40°, drums)	100 lb.	1.25 – 1.30
Sodium silicate (60°, drums)	100 lb.	2.25 – 2.40
Sodium sulphide, fused, 60-62% drums	lb.	.04½– .04¾
Sodium sulphite, crys., bbl.	lb.	.03½– .03¾
Strontium nitrate, powd., bbl.	lb.	.09½– .10¼
Sulphur chloride, yel drums	lb.	.04½– .05
Sulphur, crude	ton	18.00 – 20.00½
Sulphur dioxide, liquid, cyl.	lb.	.08 – .08
Sulphur, flour, bbl.	100 lb.	2.50 – 3.15
Sulphur, roll, bbl.	100 lb.	2.15 – 2.20
Talc—imported, bags	ton	30.00 – 40.00
Talc—domestic powd., bags	ton	18.00 – 25.00
Tin bichloride, bbl.	lb.	$.10½– $.10¾
Tin oxide, bbl.	lb.	.45 – .47
Zinc carbonate, bags	lb.	.14 – .14½
Zinc chloride, gran, bbl.	lb.	.07 – .07½
Zinc cyanide, drums	lb.	.42 – .44
Zinc oxide, XX, bbl.	lb.	.07½– .08
Zinc sulphate, bbl.	100 lb.	2.75 – 3.00

Coal-Tar Products

Alpha-naphthol, crude, bbl.	lb.	$ .95 – $1.00
Alpha-naphthol, ref., bbl.	lb.	1.05 – 1.10
Alpha-naphthylamine, bbl.	lb.	.28 – .30
Aniline oil, drums	lb.	.16½– .17
Aniline salts, bbl.	lb.	.24 – .25
Anthracene, 80%, drums	lb.	.75 – 1.00
Anthracene, 80%, imp., drums, duty paid	lb.	65 – .70
Anthraquinone, 25%, paste, drums	lb.	.70 – .75
Benzaldehyde U.S.P., carboys	lb.	1.35 – 1.40
Benzene, pure, water-white drums	gal.	.30 – .35
Benzene, 90%, drums	gal.	.28 – .32
Benzene, 90%, drums, resale	gal.	.37 – .40
Benzidine base, bbl.	lb.	.85 – .90
Benzidine sulphate, bbl.	lb.	.75 – .80
Benzoic acid, U.S.P., kegs	lb.	.70 – .75
Benzoate of soda, U.S.P., bbl.	lb.	.57 – .65
Benzyl chloride, 95-97%, ref., drums	lb.	.25 – .27
Benzyl chloride, tech., drums	lb.	.20 – .23
Beta-naphthol, subl., bbl.	lb.	.55 – .60
Beta-naphthol, tech., bbl.	lb.	.25 – .26
Beta-naphthylamine, tech.	lb.	1.00 – 1.25
Carbazol, bbl.	lb.	.75 – .90
Cresol, U.S.P., drums	lb.	.14 – .20
Ortho-cresol, drums	lb.	.18 – .22
Cresylic acid, 97-99%, drums	gal.	.60 – .65
95-97%, drums	gal.	.55 – .58
97%, resale, drums	gal.	1.00 – 1.05
Dichlorbenzene, drums	lb.	.07 – .09
Diethylaniline, drums	lb.	.50 – .60
Dimethylaniline, drums	lb.	.39 – .41
Dinitrobenzene, bbl.	lb.	.20 – .22
Dinitroclorbenzene, bbl.	lb.	.22 – .23
Dinitronaphthalene, bbl.	lb.	.30 – .32
Dinitrophenol, bbl.	lb.	.34 – .36
Dinitrotoluene, bbl.	lb.	.22 – .24
Dip oil, 25%, drums	gal.	.25 – .30
Diphenylamine, bbl.	lb.	.54 – .56
H-acid, bbl.	lb.	.75 – .80
Meta-phenylenediamine, bbl.	lb.	.95 – 1.00
Michlers ketone, bbl.	lb.	3.75 – 3.85
Monochlorbenzene, drums	lb.	.08 – .10
Monoethylaniline, drums	lb.	.95 – 1.10
Naphthalene, crushed, bbl.	lb.	.05½– .06
Naphthalene, flake, bbl.	lb.	.06 – .06½
Naphthalene, balls, bbl.	lb.	.06½– .07
Naphthionate of soda, bbl.	lb.	.58 – .65
Naphthionic acid, crude, bbl.	lb.	.60 – .65
Nitrobenzene, drums	lb.	.10 – .12
Nitro-naphthalene, bbl.	lb.	.30 – .35
Nitro-toluene, drums	lb.	.15 – .17
N-W acid, bbl.	lb.	1.20 – 1.30
Ortho-amidophenol, kegs	lb.	2.25 – 2.30
Ortho-dichlorbenzene, drums	lb.	.17 – .20
Ortho-nitrophenol, bbl.	lb.	.85 – .90
Ortho-nitrotoluene, drums	lb.	.12½– .14
Ortho-toluidine, bbl.	lb.	.14 – .16
Para-amidophenol, base, kegs	lb.	1.15 – 1.20
Para-amidophenol, HCl, kegs	lb.	1.20 – 1.25
Para-dichlorbenzene, bbl.	lb.	.17 – .20
Paranitraniline, bbl.	lb.	.75 – .80
Para-nitrotoluene, bbl.	lb.	.55 – .65
Para-phenylenediamine, bbl.	lb.	1.50 – 1.55
Para-toluidine, bbl.	lb.	.85 – .90
Phthalic anhydride, bbl.	lb.	.40 – .50
Phenol, U.S.P., drums	lb.	.34 – .35
Picric acid, bbl.	lb.	.20 – .22
Pyridine, dom., drums	gal.	1.60 – 1.75
Pyridine, imp., drums	gal.	1.40 – 1.60
Resorcinol, tech., kegs	lb.	1.50 – 1.55
Resorcinol, pure, kegs	lb.	2.00 – 2.10
R-salt, bbl.	lb.	.55 – .60
Salicylic acid, tech., bbl.	lb.	.35 – .37
Salicylic acid, U.S.P., bbl.	lb.	.40 – .42
Solvent naphtha, water-white, drums	gal.	.37 – .40
Crude, drums	gal.	.22 – .24
Sulphanilic acid, crude, bbl.	lb.	.20 – .22
Thiocarbanilide, kegs	lb.	.35 – .38
Toluidine, kegs	lb.	1.20 – 1.30
Toluidine, mixed, kegs	lb.	.30 – .35
Toluene, tank cars	gal.	.35 – .37
Toluene, drums	gal.	.40 – .43
Xylidines, drums	lb.	.40 – .45
Xylene, pure, drums	gal.	.45 – .50
Xylene pure tanks	gal.	.45 –
Xylene, com., drums	gal.	.40 – .42
Xylene, com., tanks	gal.	.30 –

Naval Stores

Rosin B-D, bbl.	280 lb.	$6.25	–
Rosin E-I, bbl.	280 lb.	6.40	–
Rosin K-N, bbl.	280 lb.	6.60	– $6.85
Rosin W.G.-W.W., bbl.	280 lb.	7.75	– 8.25
Wood rosin, bbl.	280 lb.	6.25	–
Turpentine, spirits of, bbl.	gal.	1.54	– 1.55
Wood, steam dist., bbl.	gal.	1.35	–
Wood, dest. dist., bbl.	gal.	1.25	–
Pine tar pitch, bbl.	200 lb.		– 6.00
Tar, kiln burned, bbl.	500 lb.		– 12.50
Retort tar, bbl.	500 lb.		– 11.00
Rosin oil, first run, bbl.	gal.	.43	–
Rosin oil, second run, bbl.	gal.	.47	–
Rosin oil, third run, bbl.	gal.	.53	–
Pine oil, steam dist.	gal.		– .90
Pine oil, pure, dest. dist.	gal.		– .85
Pine tar oil, ref.	gal.		– .46
Pine tar oil, crude, tanks f.o.b. Jacksonville, Fla.	gal.		– .35
Pine tar oil, double ref., bbl.	gal.		– .75
Pine tar, ref., thin, bbl.	gal.		– .25
Pinewood creosote, ref., bbl.	gal.		– .52

Vegetable Oils

Castor oil, No. 3, bbl.	lb.	$.11½	– $.12½
Castor oil, AA, bbl.	lb.	.12½	– .12½
Chinawood oil, bbl.	lb.	.14	– .14½
Coconut oil, Ceylon, bbl.	lb.	.09½	– .09½
Coconut oil, Cochin, bbl.	lb.	.09½	– .09½
Corn oil, crude, bbl.	lb.	.11	– .11½
Cottonseed oil, crude (f.o.b. mill), tanks	lb.	09½	–
Summer yellow, bbl.	lb.	.11	– .11½
Winter yellow, bbl.	lb.	.11½	– .12
Linseed oil, raw, car lots, bbl.	gal.	.87	– .88
Raw, tank cars (dom.)	gal.	.84	– .85
Boiled, 5-bbl. lots (dom.)	gal.	.89	– .90
Olive oil, denatured, bbl.	gal.	1.05	– 1.12
Palm, Lagos, casks	lb.	.07½	– .08
Palm kernel, bbl.	lb.	.08½	– .08½
Peanut oil, crude, tanks (mill)	lb.	.12½	– .12½
Peanut oil, refined, bbl.	lb.	.15½	– .16
Rapeseed oil, refined, bbl.	gal.	.85	– .86
Rapeseed oil, blown, bbl.	gal	.90	– .91
Soya bean (Manchurian), bbl.	lb.	.11½	–
Tank, f.o.b. Pacific coast	lb.	.09½	– .09¾

Fish Oils

Menhaden, light pressed, bbl.	gal.	$0.60	–
White bleached, bbl.	gal.	.64	– .65
Blown, bbl.	gal.	.68	– .69
Whale No. 1 crude, tanks, coast	lb.	.06	– .06½

Dye & Tanning Materials

Divi-divi, bags	ton	$38.00	– $39.00
Fustic, sticks	ton	30.00	– 35.00
Fustic, chips, bags	lb.	.04	– .05
Logwood, sticks	ton	28.00	– 30.00
Logwood, chips, bags	lb.	.02½	– .03½
Sumac, leaves, Sicily, bags	ton	65.00	–
Sumac, ground, bags	ton	55.00	– 60.00
Sumac, domestic, bags	ton	35.00	–
Tapioca flour, bags	lb.	.03¼	– .05

EXTRACTS

Archil, conc., bbl.	lb.	$0.18	– $0.20
Chestnut, 25% tannin, tanks	lb.	.02	– .03
Divi-divi, 25% tannin, bbl.	lb.	.04	– .05
Fustic, crystals, bbl.	lb.	.20	– .22
Fustic, liquid, 42°, bbl.	lb.	.08	– .09
Gambier, liq., 25% tannin, bbl.	lb.	.08	– .09
Hematine crys., bbl.	lb.	.14	– .18
Hemlock, 25% tannin, bbl.	lb.	.04	– .05
Hypernic, solid, drums	lb.	.24	– .26
Hypernic, liquid, 51°, bbl.	lb.	.14	– .17
Logwood, crys., bbl.	lb.	.19	– .20
Logwood, liq., 51°, bbl.	lb.	.09	– .10
Quebracho, solid, 65% tannin, bbl.	lb.	.04½	– .05
Sumac, dom., 51°, bbl.	lb.	.06½	– .07

Waxes

Bayberry, bbl.	lb.	$0.29	– $0.30
Beeswax, refined, dark, bags	lb.	.30	– .32
Beeswax, refined, light, bags	lb.	.34	– .35
Beeswax, pure white, cases	lb.	.39	– .40
Candellila, bags	lb.	.34	– .35
Carnauba, No. 1, bags	lb.	.38	– .40
No. 2, North Country, bags	lb.	.23	– .24
No. 3, North Country, bags	lb.	.17	– .17½
Japan, cases	lb.	.15	– .15½
Montan, crude, bags	lb.	.03½	– .04
Paraffine, crude, match, 105-110 m.p.	lb.	.04	– .04½
Crude, scale 124-126 m.p., bags	lb.	.02½	– .02¾
Ref., 118-120 m.p., bags	lb.	.03½	– .03¾
Ref., 125 m.p., bags	lb.	.03¾	– .03¾
Ref, 128-130 m.p., bags	lb.	.04	– .04¼
Ref., 133-135 m.p., bags	lb.	.04½	– .04¾
Ref., 135-137 m.p., bags	lb.	.05	– .05½
Stearic acid, sgle pressed, bags	lb.	.10	– .10½
Double pressed, bags	lb.	.10½	– .10¾
Triple pressed, bags	lb.	.11	– .11½

Fertilizers

Ammonium sulphate, bulk, f.o.b. works	100 lb.	$3.20	– $3.25
F.a.a. double bags	100 lb.	3.60	– 3.75
Blood, dried, bulk	unit	4.60	–
Bone, raw, 3 and 50, ground	ton	30.00	– 35.00
Fish scrap, dom., dried, wks.	unit	5.00	– 5.10
Nitrate of soda, bags	100 lb.	2.60	– 2.65
Tankage, high grade, f.o.b. Chicago	unit	4.60	– 4.65
Phosphate rock, f.o.b. mines, Florida pebble, 68-72%	ton	$3.50	– $4.00
Tennessee, 78-80%	ton	7.00	– 8.00
Potassium muriate, 80%, bags	ton	35.55	– 38.25
Potassium sulphate, bags	unit	1.00	–

Crude Rubber

Para—Upriver fine	lb.	$0.25½	– $0.25½
Upriver coarse	lb.	.18½	– .18½
Upriver caucho ball	lb.	.20½	– .20½
Plantation—First latex crepe	lb.	.28½	– .29
Ribbed smoked sheets	lb.	.28½	– .29
Brown crepe, thin, clean	lb.	.23	– .23½
Amber crepe No. 1	lb.	.23	– .23¼

Miscellaneous Materials

Asbestos, crude No. 1, f.o.b., Quebec, sh. ton		$450.00	– $550.00
Asbestos, shingle, f.o.b., Quebec, sh. ton		60.00	– 80.00
Asbestos, cement, f.o.b., Quebec, sh. ton		15.00	– 17.00
Barytes, grd., white, f.o.b. mills, bbl., net ton		16.00	– 20.00
Barytes, grd., off-color, f.o.b. mills bulk, net ton		13.00	– 21.00
Barytes, floated, f.o.b. St. Louis, bbl., net ton		24.00	– 28.00
Barytes, crude f.o.b. mines, bulk, net ton		8.00	– 9.00
Casein, bbl., tech.	lb.	.12	– .14
China clay (kaolin) crude, f.o.b. Ga., net ton		7.00	– 9.00
Washed, f.o.b. Ga., net ton		8.00	– 9.00
Powd., f.o.b. Ga., net ton		14.00	– 20.00
Crude f.o.b. Va., net ton		8.00	– 12.00
Ground, f.o.b. Va., net ton		13.00	– 20.00
Imp., lump, bulk, net ton		14.00	– 20.00
Imp., powd., net ton		40.00	– 45.00
Feldspar, No. 1 pottery, long ton		6.00	– 7.00
No. 2 pottery, long ton		5.00	– 5.50
No. 1 soap, long ton		7.00	– 7.50
No. 1 Canadian, f.o.b. mill, long ton		20.00	– 21.00
Graphite, Ceylon, lump, first quality, bbl.	lb.	.05	– .05½
Ceylon, chip, bbl.	lb.	.04	– .04½
High grade amorphous crude, ton		35.00	– 50.00
Gum arabic, amber, sorts, bags	lb.	.15	– .16
Gum tragacanth, sorts, bags	lb.	.50	– .60
No. 1, bags	lb.	1.75	– 1.80
Kieselguhr, f.o.b. Cal.	ton	40.00	– 42.00
F.o.b. N. Y.	ton	50.00	– 55.00
Magnesite, crude, f.o.b. Cal.	ton	14.00	– 15.00
Pumice stone, imp., casks	lb.	.03	– .05½
Dom., lump, bbl.	lb.	.05	– .05½
Dom., ground, bbl.	lb.	.06	– .07
Shellac, orange fine, bags	lb.	.74	– .75
Orange superfine, bags	lb.	.76	– .77
A. C. garnet, bags	lb.	.75	– .77
T. N., bags	lb.	.72	– .73
Silica, glass sand, f.o.b. Ind.	ton	2.00	– 2.50
Silica, sand blast, f.o.b. Ind.	ton	2.50	– 5.00
Silica, amorphous, 250-mesh, f.o.b. Ill.	ton	17.00	– 17.50
Silica, bldg. sand, f.o.b. Pa.	ton	2.00	– 2.75
Soapstone, coarse, f.o.b. Vt., bags	ton	7.00	– 8.00
Talc, 200 mesh, f.o.b., Vt., bags	ton	6.50	– 9.00
Talc, 200 mesh, f.o.b. Ga., bags	ton	7.00	– 9.00
Talc, 200 mesh, f.o.b. Los Angeles, bags	ton	16.00	– 20.00

Refractories

Bauxite brick, 56% Al_2O_3, f.o.b. Pittsburgh	ton	$45–50
Chrome brick, f.o.b. Eastern shipping points	ton	50–52
Chrome cement, 40-50% Cr_2O_3	ton	23–27
40-45% Cr_2O_3, sacks, f.o.b. Eastern shipping points	ton	23.00
Fireclay brick, 1st. quality, 9-in. shapes, f.o.b. Ky. wks.	1,000	40–46
2nd. quality, 9-in. shapes, f.o.b. wks.	1,000	36–41
Magnesite brick, 9-in. straight (f.o.b. wks.)	ton	65–68
9-in. arches, wedges and keys	ton	80–85
Scraps and splits	ton	85
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	48–50
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	48–50
F.o.b. Mt. Union, Pa.	1,000	42–44
Silicon carbide refract. brick, 9-in.	1,000	1,100.00

Ferro-Alloys

Ferrotitanium, 15-18% f.o.b. Niagara Falls, N. Y.	ton	$200.00	– $225.00
Ferrochromium, per lb. of Cr, 6-8% C	lb.	.11	– .11½
4-6% C	lb.	.11½	– .12
Ferromanganese, 78-82% Mn, Atlantic seabd. duty paid	gr. ton	100.00	– 105.00
Spiegeleisen, 19-21% Mn.	gr. ton	35.00	– 37.00
Ferromolybdenum, 50-60% Mo, per lb. Mo.	lb.	1.90	– 2.15
Ferrosilicon, 10-15%	gr. ton	40.00	– 45.00
50%	gr. ton	75.00	– 80.00
75%	gr. ton	115.00	– 120.00
Ferrotungsten, 70-80%, per lb. of W.	lb.	$0.90	– $0.95
Ferro-uranium, 35-50% of U. per lb. of U.	lb.	6.00	–
Ferrovanadium, 30-40%, per lb. of V.	lb.	3.50	– 4.00

Ores and Semi-finished Products

Bauxite, dom. crushed, dried, f.o.b. shipping points	ton	$6.00	– $9.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	ton	22.00	– 23.00
C.i.f. Atlantic seaboard	ton	18.50	– 19.00
Coke, fdry., f.o.b. ovens	ton	9.00	– 9.50
Coke, furnace, f.o.b. ovens	ton	9.00	– 9.50
Fluorspar, gravel, f.o.b. mines, New Mexico	ton	17.50	–
Fluorspar, std., dom. washed gravel Ky. & Ill. mines	ton	21.50	– 22.00
Ilmenite, 52% TiO_2	lb.	.01½	– .01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.45	–
Manganese ore, chemical (MnO_2)	ton	75.00	– 80.00
Molybdenite, 85% MoS_2, per lb. MoS_2, N. Y.	lb.	.80	– .85
Monazite, per unit of ThO_2, c.i.f., Atl. seaport	lb.	.06	– .08
Pyrites, Span., fines, c.i.f. Atl. seaport	unit	.11½	– .12
Pyrites, Span., furnace size, c.i.f. Atl. seaport	unit	.11½	– .12
Pyrites, dom. fines, f.o.b. mines, Ga.	unit	Nominal	
Rutile, 95% TiO_2	lb.	.12	–
Tungsten, scheelite, 60% WO_3 and over, per unit WO_3	unit	8.00	– 8.50
Tungsten, wolframite, 60% WO_3 and over, per unit WO_3	unit	7.50	– 8.00
Uranium ore (carnotite) per lb. of U_3O_8	lb.	3.50	– 3.75
Uranium oxide, 96% per lb. U_3O_8	lb.	2.25	– 2.50
Vanadium pentoxide, 99%	lb.	12.00	– 14.00
Vanadium ore, per lb. V_2O_5	lb.	1.00	–
Zircon, washed, iron free, f.o.b. Pablo, Fla.	lb.	.04½	– .13

Non-Ferrous Materials

	Cents per Lb.
Copper, electrolytic	14.75
Aluminum, 98 to 99%	22.00–23.00
Antimony, wholesale, Chinese and Japanese	6.35
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	32.00–33.00
Nickel, ingot and shot, resale	36.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	38.625
Lead, New York, spot	7.25
Lead, E. St. Louis, spot	7.125
Zinc, spot, New York	7.25
Zinc, spot, E. St. Louis	6.90–7.00

OTHER METALS

Silver (commercial)	oz.	$0.64½
Cadmium	lb.	1.15
Bismuth (500 lb. lots)	lb.	2.45
Cobalt	lb.	3.00@3.25
Magnesium, ingots, 99%	lb.	1.00@1.05
Platinum	oz.	118.00
Iridium	oz.	240.00@275.00
Palladium	oz.	65.00
Mercury	75 lb.	74.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.00
Copper bottoms	30.00
Copper rods	19.75
High brass wire	18.75
High brass rods	16.75
Low brass wire	19.60
Low brass rods	20.25
Brazed brass tubing	27.00
Brazed bronze tubing	28.00
Seamless copper tubing	24.75
Seamless high brass tubing	22.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

Copper, heavy and crucible	11.00@11.25
Copper, heavy and wire	10.50@10.75
Copper, light and bottoms	8.50@8.75
Lead, heavy	4.50@4.75
Lead, tea	3.25@3.50
Brass, heavy	5.50@5.75
Brass, light	5.00@5.25
No. 1 yellow brass turnings	5.50@5.75
Zinc	2.25@2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Chicago
Structural shapes	$2.90	$2.90
Soft steel bars	2.80	2.80
Soft steel bar shapes	2.80	2.80
Soft steel bands	3.40	3.40
Plates, ¼ to 1 in. thick	2.90	2.90

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

SYLACAUGA—The Sylacauga Fertilizer Co. has completed plans for the immediate erection of a new 1-story plant, 30x100 ft., for the production of commercial fertilizer. Another unit of like size will be constructed as soon as the first building has been completed.

HOLT—The Central Foundry Co. has commenced enlargements in its local plant, including remodeling work. It is proposed to convert the structure into a hand-molding shop for the manufacture of pipe and fittings. It has been closed for about a year past. Headquarters of the company are at 41 East 42nd St., New York.

California

SAN FRANCISCO—The Los Angeles Soap Co., 633 East 1st St., Los Angeles, manufacturer of soaps, washing powders, refined cottonseed oils, etc., will soon take bids for the erection of its proposed 2-story and basement plant at 2nd and Brannan Sts., San Francisco, estimated to cost $80,000, including equipment. W. H. Crim, Jr., 425 Kearny St., San Francisco, is architect.

LOS ANGELES—The California Enameling Co. will soon break ground for the construction of a new 1-story plant at 51st St and Santa Fe Ave., 300x600 ft., for the manufacture of enameled products. Hamm & Grant, Ferguson Bldg., are architects.

SEBASTOPOL—The Western Apple Vinegar Co., McKinley St., has acquired property adjoining its plant and plans for the erection of a new dehydrator works. Bids will be asked at an early date.

LOS ANGELES—The Pacific Coast Borax Co., Kohl Bldg., San Francisco, has increased the size of its proposed new refinery at Los Angeles Harbor from 2- to 3-story, of size 250x305 ft. A general contract for erection will soon be let. The complete plant will cost in excess of $1,200,000, including machinery. Albert C. Martin, Higgins Bldg., Los Angeles, is architect.

LOS ANGELES—The Shell Oil Co., 343 Sansome St., San Francisco, has leased a tract of land totaling about 5 acres on Mormon Island, San Pedro, as a site for the construction of a new storage and distributing plant. Plans will be prepared at an early date. The estimated cost is reported in excess of $90,000, with equipment.

Connecticut

HARTFORD—The Lotz Asbestos Co., 60 Prospect St., manufacturer of special cements, asbestos specialties, etc., has acquired a 2-story factory on site 100x130 ft., at 479 Windsor St., for a new plant for increased production. The structure will be improved and enlarged with the construction of two additional stories. Early occupancy is planned.

BERLIN—The Hall-Spiers Brick Co., recently organized with a capital of $75,000, will succeed the company of the same name operating a local plant. Extensions are planned, including the installation of equipment for oil-burning for klin service. F. M. Hall is president, and Paul H. Spiers, vice-president and secretary.

Florida

OCALA—The Loncala Phosphate Co., P.O. Box 471, is planning for the installation of brick-manufacturing equipment at its plant. Inquiries are being made for hand-power or gasoline engine-operated apparatus.

Georgia

ATLANTA—The United Paper Co., manufacturer of fruit-wrapping and other paper products, has tentative plans under consideration for the erection of a new 5-story building on local site, to cost about $200,000.

Illinois

CHICAGO—The Enamel Steel Sign Co., 190 North State St., has completed plans and is taking bids for the erection of a 1- and 2-story plant on West Ravenswood Ave., 100x160 ft. Arthur H. Knox, 7 West Madison St., is architect. Manly Simmons is president.

CHICAGO—Gutman & Co., Webster Ave. and Dominick St., leather tanners, have plans nearing completion for the erection of additions to their plant, including a main 1-story extension, 40x160 ft., for general production; 1- to 3-story beam house, 37x145 ft.; and carpenter and woodworking shop, 40x66 ft. The structures are estimated to cost $50,000.

CHICAGO—The Patterson-Sargent Co., 2025 Lumber St., manufacturer of varnishes, paints, etc., with headquarters at Cleveland, O., has completed foundations and will proceed the superstructure for its new branch plant at Seward and Lumber Sts., estimated to cost about $175,000. A. E. Fenn is local manager.

Indiana

EAST CHICAGO—The Pressed Steel Mfg. Co., 20 West Jackson Blvd., Chicago, Ill., has plans nearing completion for the erection of a new plant at East Chicago, to be 2-story, estimated to cost in excess of $100,000. Frank D. Chase, Inc., 645 North Michigan Ave., Chicago, is architect and engineer. Walter P. Murphy is president.

Kentucky

SCOTTSVILLE—The Massey Oil & Refining Co., recently organized, will succeed to the plant and business of the Massey Refining Co. Extensions and improvements are planned in the present refinery. W. E. Massey, Louisville, is president.

Louisiana

NEW ORLEANS—The Prest-O-Lite Co., Indianapolis, Ind., manufacturer of acetylene apparatus, has awarded a contract to J. V. and R. T. Burkes, New Orleans, for the erection of the initial buildings for its proposed new local plant. A group of ten structures will be erected, estimated to cost in excess of $150,000 with equipment. The company is operated by the Union Carbide Co., 30 East 42nd St., New York, N. Y.

MONROE—The Monroe-Louisiana Carbon Co., DeKalb and Zepp Sts., St. Louis, Mo., has commissioned Chauncey Matlock, 949 Broadway, New York, consulting engineer, to prepare plans for its proposed new plant at Ladel, near Monroe, to have an initial daily output of about 5,000 lb. of carbon black. The majority of equipment will be electrically operated. The buildings to be erected at the present time will cost about $100,000, and this appropriation will be increased at a later date.

Maryland

BALTIMORE—The Crown Oil & Wax Co., Pratt and 8th Sts., has filed plans for the erection of a 1-story addition, 45x88 ft. The contract for construction has been let to Charles E. Ehrman & Sons, Baltimore.

DUNKIRK—The Dashiell Mining & Refining Co. is planning for extensive developments on local rare earth deposits. A plant will be installed with conveyor system and other mechanical apparatus. B. J. Dashiell, Baltimore, is consulting engineer for the company.

Michigan

MONROE—The Monroe Paper Products Co. has commenced the erection of a new addition to its plant, 75x225 ft., to be equipped for the employment of about 50 operatives.

GRAND LODGE—The Briggs Clay & Mfg. Co., has tentative plans under consideration for the rebuilding of the portion of its plant, destroyed by fire, Dec. 20, with loss reported at $17,000.

CALUMET—The Calumet & Hecla Co., operating copper mining and smelting properties, has work under way on a plant for the treatment of Tamarack conglomerate sands for local service.

CHEBOYGAN—Fire, Dec. 22, destroyed a portion of the foundry of the Cheboygan Brass Foundry Co., with loss estimated at about $12,000. It is planned to rebuild.

PONTIAC—The Pontiac Varnish Co., has plans under way for the erection of a new plant addition to cost about $25,000. C. H. Hutchins is president.

NEW BALTIMORE—Charles Reimold and R. A. Waterbury, Mt. Clemens, Mich., are organizing a company to construct and operate a local plant for the manufacture of brick and other burned clay products. Options have been secured on a tract of clay property for the plant site.

DETROIT—Robert Finn, 622 McKeachey Bldg., architect, has plans in progress for a new foundry, 1-story, 50x140 ft., estimated to cost about $15,000, to be erected on local site. The name of the owner is temporarily withheld.

ST. JOSEPH—The local plant of the Mullen Brothers Paper Co. has been acquired at a sale in bankruptcy by Francis Hughes, Chicago, Ill., and associates, for a consideration of about $70,000. The new owners are said to be planning for a reorganization of the company and the operation of the mill, including proposed extensions and improvements.

Minnesota

HIBBING—The Water & Light Department, D. D. Haley, secretary, has awarded a general contract to the Phelps Brake Co., Hibbing, for the erection of a 1-story and basement addition to the municipal artificial gas plant, 35x66 ft., estimated to cost about $90,000. Charles Foster, Sellwood Bldg., Duluth, Minn., is engineer.

Mississippi

MOSS POINT—The Southern Paper Co. has plans nearing completion for the erection of a new pulp and paper mill at its local plant, with daily output of about 120 tons, equally divided between pulp and paper. It is expected to call for bids at an early date. George F. Hardy, 309 Broadway, New York, N. Y., is engineer. J. L. Dantzler is president.

Missouri

KANSAS CITY—The Schreiber Flour & Cereal Co. has tentative plans under consideration for the rebuilding of the portion of its 5-story mill, destroyed by fire, Dec. 15, with loss approximating $125,000, including equipment.

New Jersey

NEWARK—The Department of Streets and Public Improvements will install a complete chemical laboratory in the new building to be constructed for the Bureau of Water at Cedar Grove. It will cost about $20,000.

NEWARK—The Board of Education, City Hall, is considering the installation of additional equipment in the chemistry department at the new Seymour Vocational School, Sussex Ave. It is also planned to install foundry apparatus and other equipment in the different departments.

Ohio

UTICA—The Licking Window Glass Co. has completed plans and will soon break ground for the construction of a 1-story addition, 148x160 ft., estimated to cost about $35,000. It will be equipped for the production of plate glass. The Truscon Engineering Co., Ferris Bldg., Columbus, O., is engineer in charge. H.H S. McCann is secretary.

SHELBY—The Ohio Seamless Tube Co. will soon commence the construction of a plant addition, 100x280 ft., to be used primarily for the production of cold drawn tubing. Other plant extensions are contemplated. The work is estimated to cost approximately $200,000, including machinery.

Oklahoma

CHICKASHA—The Chamber of Commerce, J. W. Comer, secretary, is perfecting plans for the construction and operation of a local plant for the manufacture of glass products. It is proposed to organize a company to carry out the project. Plans are also being discussed for the establishment of a local mill for the manufacture of corrugated paper products.

PERRY—The Garber Oil Refining Co. is said to have plans under way for the construction of an addition to its local refinery. E. A. Hutcheson is general manager

Pennsylvania

JEANNETTE—The American Window Glass Co., Farmers' Bank Bldg., Pittsburgh, has arranged an appropriation of approximately $250,000, for the proposed addition to its local plant, on which work has been commenced. A general contract has been awarded to the Bollinger-Andrews Co., Empire Bldg., Pittsburgh. William L. Monroe is president.

CHESTER—The Stauffer Chemical Co., 624 California Ave., San Francisco, Calif., has awarded a contract to the Chester Construction & Contracting Co., Chester, for the erection of the first unit of its proposed new plant on Front St., Trainer, near Chester, estimated to cost approximately $165,000.

WEST READING—The A. Wilhem Co., manufacturer of enamels, paints, etc., has tentative plans under consideration for the rebuilding of its local plant, destroyed by fire Dec. 24, with loss reported at $14,000.

PITTSBURGH—The Vitro Mfg. Co., Bessemer Bldg., manufacturer of enamels and kindred products, has filed plans for the construction of its proposed 1-story plant on Oliffe St., and will commence immediate erection. It is estimated to cost about $10,000.

PHILADELPHIA—The Quaker City Japanning & Enameling Co. has leased a floor in the building at Buttonwood and 10th Sts., for the establishment of a local plant.

CREIGHTON—The Pittsburgh Plate Glass Co., Frick Bldg., Pittsburgh, is perfecting plans for the construction of a local plant, to be equipped primarily for the manufacture of plate glass products for automobile service. It will have a capacity of more than 15,000,000 ft. per year, and is estimated to cost in excess of $200,000.

LOWER GWYNEDD—The American Chemical Paint Co., 1126 South 11th St., Philadelphia, is completing plans and will take bids during January for the construction of a new plant here, on Brookside Ave. J. Harvey Gravell is president.

PHILADELPHIA—A. Waxman & Co., 424 North 3rd St., glass products, has acquired adjoining property, and a 4-story factory in the immediate vicinity at 417-21 North Orianna St., 50x78 ft., for a consideration of about $35,000, for proposed expansion.

Tennessee

KNOXVILLE—The Cherokee Brick Co., recently organized, has acquired a tract of property in the Chestnut Ridge section, comprising about 20 acres of land, as a site for a new plant for the manufacture of face brick and other burned clay products. The initial works will have a capacity of about 40,000 bricks per day, and is estimated to cost in excess of $125,000. J. Albert Robbins is president, and E. C. Wright, secretary.

MEMPHIS—The Board of Public Works will commence the immediate installation of a filtration plant in connection with extensions and improvements in the municipal waterworks, to cost close to $1,500,000.

Texas

FERRIS—The Globe Pressed Brick Co. is planning for the rebuilding of the portion of its plant, destroyed by fire Dec. 19. An official estimate of loss has not been made.

Virginia

HOPEWELL—The Stamsocott Co. Inc., manufacturer of pulp and paper products, has work under way on enlargements in its plant, for considerable increase in capacity. The present working force of 350 men will be materially increased in the near future.

HOPEWELL — The Hummel-Ross Fibre Corp. is completing the erection of a new mill for the production of kraft paper, with daily capacity of about 50 tons, and plans to place the unit in service at an early date. The output at the pulp mill, on adjoining site, will be increased from 50 to 100 tons in the near future.

Washington

SEATTLE—The Concrete Pipe Co. is planning for the installation of a testing laboratory in a new 1-story and basement building, for which plans are now being prepared. A. H. Albertson, Henry Bldg., is architect.

TACOMA—Fire recently destroyed a portion of the plant of the Continental Pipe Co., 1612 Center St., with loss estimated at approximately $75,000. The plant has been operated under lease by the Washington Wood Products Co. It is planned to rebuild.

West Virginia

WHEELING—The B. & M. Metal Rolling Mill, 36th and McCulloch Sts., has perfected plans for the operation of a local plant for the manufacture of bronze rods and kindred specialties. It is proposed to develop a daily output of about 25 tons. W. J. Broddock is president.

Wisconsin

MILWAUKEE — The Rickertron Mineral Paint Co., South Bay St., has preliminary plans in preparation for the construction of a new 1-story and basement plant, 63x70 ft., on Wilcox St., to cost approximately $25,000. The Birkholz Engineering Co., 290 3rd St., is architect and engineer.

Industrial Developments

GLASS—The American Window Glass Co., Pittsburgh, Pa., is advancing production at its plants, with employment of additional workers. During 4 weeks near the close of last year, 567 carloads of window glass were shipped, establishing a new high record.

The Republic Glass Co., Monroe, Mich., is arranging for the immediate operation of its new local plant, recently completed at a cost of about $100,000, and will specialize in the manufacture of lenses and kindred high-grade glassware. A full working force will be employed. M. M. Llera is president, and W. N. Mathews, vice-president and general manager.

CERAMIC—The Hopewell China Corp. is planning for increased production at its pottery, including the installation of 2 new decorating kilns. The present equipment comprises 7 general ware and 6 decorating kilns, with total output of approximately 12,000 doz. pieces per week. The working force of 225 employees will be increased at an early date.

Practically all of the general ware potteries at East Liverpool, O., have resumed production, following the close of the operatives' strike, under full capacity schedule. It is said that orders received have booked a number of plants for the entire year to come.

Brick-manufacturing plants in the Birmingham, Ala., district are all running on a full time schedule, with regular working forces, and a record production is expected during 1923.

The Metropolitan Paving Brick Co., Canton, O., is operating at full capacity at all of its plants, and it is expected to maintain this schedule for a number of weeks to come.

The Chelsea China Co., New Cumberland, W. Va., has resumed operations at its plant, after a shut down of a number of weeks, and plans to develop maximum output in the line of hotel ware. A number of improvements are planned to facilitate operations.

The Corning Brick, Terra Cotta & Tile Works, Corning, N. Y., is increasing production of brick and terra cotta. Employment is being given to close to 45 per cent more men than at this time a year ago, with early extensions contemplated in the working force.

The Canton Brick & Fireproofing Co., Canton, O., is advancing operations at its plant and expects to develop capacity, with full working force.

The Alton Brick Co., Alton, Ill., is arranging for the early resumption of production at the former plant of the Banner Clay Works, Edwardsville, Ill., recently acquired. Extensions and improvements will be made, including the installation of additional equipment.

The What Cheer Clay Products Co., What Cheer, Ia., will operate under maximum output, following the completion of additions and improvements. It is expected to develop a capacity of close to 35,000 tons of material per annum.

IRON AND STEEL—The Marietta Furnace, Marietta, Pa., has resumed operations after a shut down of about 2 years, giving employment to about 100 men. It is expected to maintain production for an indefinite period.

The Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., has resumed production at its finishing mills, following a brief curtailment during the holidays. The plant will run on a double turn under maximum operating schedule. The Fairfield plate mill of the company is running full, and has orders on hand to insure full capacity for a number of weeks to come. The third blast furnace at Bessemer, Ala., has been blown in on foundry iron, and a fourth unit will be placed in service at an early date. All six furnaces of the company at Ensley are in blast.

The Thomas Iron Co., Hokendauqua, Pa., is planning to blow in its local blast furnace about Jan. 15. A full working force will be employed under a capacity schedule.

The Gulf States Steel Co., Birmingham, Ala., is arranging to place its finishing mills on a double turn at an early date.

The Glasgow Iron Co., Pottstown, Pa., has placed its puddle mill in operation after an idle period dating back to 1918. A number of improvements have been made in the plant. It is expected to maintain production for an indefinite period. The universal mill and plate mill of the company are now in service on full turn.

The Interstate Iron & Steel Co., Chicago, Ill., is maintaining production at its alloy steel mills at close to capacity, with employment of regular working force.

The United States Steel Corp., Pittsburgh, Pa., is operating at its different plants at about 83 per cent of normal, the highest rate of production throughout 1922.

The Reading Iron Co., Reading, Pa., is running full at its plate mill and one of its puddle mills, and plans to maintain this basis for some time to come. The 8 plants of the company in neighboring sections are also on full turn.

Steel mills in the Chicago, Ill., district are operating on a basis of 75 to 80 per cent of normal, with prospects for early increase.

The Carpenter Steel Co., Reading, Pa., is maintaining full operations at its plant and is said to have advance orders to insure this basis for some time to come.

METALS—The Hoover Steel Ball Co., Chelsea, Mich., is planning for the early resumption of operations at its local plant, which has been closed down since late in 1920.

The Utah Copper Co., Salt Lake City, Utah, has placed another unit in operation at its new Magna mill, making 3 sections now in service. Other units are in the course of construction and will be placed in operation as soon as completed, or on the basis of 2 units a month. The mill will consist of 12 units.

The Chino Copper Co., Santa Rita, N. M., is maintaining close to normal operations at its local properties and an average of 600 tons of concentrates are being sent to the mill daily. The mill is running on a similar production schedule of 600 tons per day.

Pipe foundries in the vicinity of Birmingham, Ala., are running at capacity and a number of plants are arranging for immediate expansion. The Birmingham Machine & Foundry Co. proposes to construct a new foundry addition for the production of sanitary pipe. The National Cast Iron Pipe Co. will soon commence the erection of an extension to its pipe foundry at Tarrant City, and the McWane Cast Iron Pipe Co. has broken ground for its proposed new plant in the East Birmingham district.

The Tonopah Extension Mining Co., Tonopah, Nev., is arranging for capacity production at the local McNamara mill, recently secured under lease. Operations will be on a basis of about 100 tons per day.

The Consolidated Cortez Mining Co., Cortez, Nev., is completing the construction of a new mill and plans to place the unit in service at an early date. Initial production will be on the basis of 100 to 150 tons of handled ore per day.

The National Tin Co., Hill City, S. D., is arranging for increased production at its plant, and proposes to develop an output that will produce about 125 tons of metal at the smelter per month.

MISCELLANEOUS — The Widen-Lord Tanning Co., Danvers, Mass., is maintaining full production at its local tannery, specializing in the production of elk leathers.

H. B. Johnston & Co., Toronto, Ont., are running full at their local tannery for the production of calf leathers. A full working force is being employed.

The Owosso Sugar Co., Owosso, Mich., is operating at full capacity at its local mill. Plans are being considered for the reopening of the Lansing, Mich., plant of the company, which has been inactive since last June.

The Mt. Clemens Sugar Co., Mt. Clemens, Mich., is running full at its local mill, which has been in active service since Oct. It is expected to maintain the present schedule for a number of weeks.

E. I. du Pont de Nemours & Co., Wilmington, Del., are discontinuing operations at their plant in Wayne Township, near Paterson, N. J., heretofore devoted to the production of black powder. The machin-

ery will be removed to a works at Hillsdale Junction, near Scranton, Pa.

The Producers' & Refiners' Co., Fort Steele, Wyo., has completed the construction of the first unit of its new local refinery, and plans to place the plant in operation early in February. It will operate on a basis of 5,000 bbl. per day.

The Electro-Chemical Co. of Canada, Niagara Falls, Ont., is planning to operate a local plant for the production of nitric acid for general commercial use. A department will also be operated for the manufacture of calcium nitrate fertilizers. Existing plant facilities will be arranged for the new production with continuance of operations for present products.

The Calera Lime Works, Inc., Birmingham, Ala., is maintaining capacity production at its plant, and owing to heavy orders eliminated the annual shut-down during the holidays. A new kiln has been installed and other plant extensions will be made. A full working force is employed.

The Union Bag & Paper Co., Cheboygan, Mich., is increasing production at its plant, and machinery idle for some time past has been placed in service. Present operations are on a basis of about 70 tons of paper per day, and this will be increased to more than 100 tons daily at an early date.

The Michigan Sugar Co. has full-time production in force at its Caro, Mich., mill with employment of regular working quota. It is proposed to maintain capacity ouput for some time to come.

New Companies

THE CAVALIER CHEMICAL CO., Winston-Salem, N. C., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are E. M. Spivey and Wesley Taylor, both of Winston-Salem.

THE PENINSULA RUBBER CO., Boston, Mass., has been incorporated with a capital of $90,000, to manufacture rubber products. Andrew P. Keegan is president, and Lawrence F. Keegan, 505 East 6th St., South Boston, treasurer. The last noted represents the company.

THE PREFERRED CHEMICAL CORP., New York, N. Y., care of Isador Leifer, 110 West 40th St., New York, representative, has been incorporated with a capital of $20,000, to manufacture chemicals and chemical byproducts. The incorporators are S. D. Silverman, A. Siegel and E. M. Neilson.

THE ATLAS PULVERIZING CO., 136 West Lake St., Chicago, Ill., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture paints, pigments, etc. The incorporators are Samuel E. Hirsch, Eugene I. Kalmuk and H. V. Gressang.

THE ESSEX ANALYTICAL LABORATORIES, INC., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals and affiliated products. The incorporators are Paul C. Schotte, William A. Tries and Charles B. Clancy, 810 Broad St., Newark. The last noted represents the company.

THE COATES BRICK & TILE CO., Kansas City, Mo., has been incorporated with a capital of $15,000, to manufacture brick, tile and other burned clay products. The incorporators are W. W. Coates, A. O. Kickel and A. J. Moorhead, all of Kansas City.

JOSEPH A. MAGILO, INC., New York, N. Y., care of J. A. O'Rourke, 299 Broadway, representative, has been incorporated with a capital of $10,000, to manufacture chemical specialties. The incorporators are J. A. Magilo and S. S. Bemstein.

THE MOORE OIL & REFINING CO., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of $500,000, to manufacture refined oil products.

THE CALIFORNIA PRODUCTS CO., Houston, Tex., has been incorporated with a capital of $25,000, to manufacture extracts, vinegar, etc. The incorporators are G. A. MacFarland, A. D. Baker and O. E. Gilleland, all of Houston.

THE SANFORD MFG. CO., 846 West Congress St., Chicago, Ill., has been incorporated with a capital of $250,000, to manufacture inks, pastes, sealing wax and kindred specialties. The company is operating a plant at Congress and Peoria Sts. The incorporators are William K. Otis, Roy P. Kelley and William C. Boyden, Jr.

THE NATIONAL CHEMICAL PRODUCTS CO., Union Hill, N. J., care of Edward Hollander, 8 Bergenline Ave., Union Hill, representative, has been incorporated with a capital of $125,000, to manufacture chemicals and chemical byproducts. The incorporators are Richard D. Zucker and Joseph C. Bender.

THE SMITH-ALSOP SOUTH BEND PAINT CO., South Bend, Ind., has been incorporated with a capital of $25,000, to manufacture paints, varnishes, oils, etc. The incorporators are Edward A. White, Guy W. Frederick and Floyd E. Dix, all of South Bend.

THE MOAVA PRODUCTS CORP., Rochester, N. Y., Care of Reed, Shutt, Downs & Shutt, Wilder Bldg., Rochester, representatives, has been incorporated with a capital of $650,000, to manufacture chemicals and chemical byproducts. The incorporators are E. W. Hinman, F. W. Clements and F. W. Townsend.

THE SOUTHERN BRICK CO., Knoxville, Tenn., has been incorporated with a capital of $25,000, to manufacture brick, tile and other burned clay products. The incorporators are Reed P. Black, Leo I. Fanz, and Charles H. Smith, all of Knoxville.

THE GOLDEN WEST PETROLEUM CORP., Los Angeles, Calif., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws, with capital of $10,000,000, to manufacture refined petroleum products. The incorporators are Sherman S. Clark, James E. Kelby and King C. Gillette, all of Los Angeles.

THE GARDINER FOIL CO., 1356 West Lake St., Chicago, Ill., has been incorporated with a capital of $100,000, to manufacture tin foil and other composition foils. The incorporators are Robert A. and Harry J. Gardiner and F. W. Murray.

THE HALL-SPIERS BRICK CO., Berlin, Conn., has been incorporated with a capital of $75,000, to manufacture brick, sewer pipe, tile and other burned clay products. The incorporators are Wilson and Paul H. Spiers, Cambridge, Mass.; and Frederick M. Hall, 77 Wallace St., New Britain, Conn. The last noted represents the company.

THE VALE CHEMICAL CO., care of the Capital Trust Co. of Delaware, Dover, Del., representative, has been incorporated under Delaware laws, with a capital of $100,000, to manufacture chemicals and chemical byproducts.

THE CITY CHEMICAL CO., Jersey City, N. J., has been incorporated with a capital of $125,000, to manufacture chemicals and chemical byproducts. The incorporators are Henry, Jerome and Max Wolpert, 67 Van Winkle Ave., Jersey City. The last noted represents the company.

THE KEYSTONE CARBON CO., Huntington, W. Va., has been incorporated with a capital of $2,000,000, to manufacture carbon and oil products. The incorporators are T. W. Scott, H. Blaidell and H. T. Lovett, all of Huntington.

THE ILLINOIS GLASS CO., 402 West Randolph St., Chicago, Ill., has been incorporated with a capital of $11,100,000, to manufacture bottles and other hollowware. The company is now operating plants at Alton, Ill., Bridgeton, N. J., and other points. The incorporators are John M. Levis, E. M. Ashcroft, Jr., and C. J. Lord.

THE CAPITOL BRICK CO., Newark, N. J., care of Gifford & Miller, 763 Broad St., Newark, representatives, has been incorporated with a capital of 20,000 shares of stock, no par value, to manufacture brick, tile and other burned clay products. The incorporators are Arthur H. Wolfe, Clarence S. Dame, and C. G. Towne.

THE HANSEN RUBBER PRODUCTS CO., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws, with a capital of $250,000, to manufacture rubber products.

THE BELL LEATHER CORP., Peabody, Mass., has been incorporated with a capital of $10,000, to manufacture leather products. Rogers M. Crehore, 20 Chase St., Danvers, Mass., is president and treasurer, and represents the company.

THE FLORIDA HUMUS CO., Zellwood, Fla., has been incorporated with a capital of $200,000, to manufacture fertilizer products. John A. Hayes is president; Robert J. Rosenthal, vice-president; and Michael J. Perez, secretary, all of Zellwood. The same officials have also organized the ALPHA CO., with similar capital of $200,000, and location, to manufacture like products.

THE PHYMOS CHEMICAL LABORATORIES, INC., Pensacola, Fla., has been incorporated with a capital of $45,000, to manufacture chemicals and chemical byproducts. The incorporators are V. J. and John J. MacIntire, both of Pensacola.

THE GENERAL PLATING WORKS, INC., 2600 Prairie Ave., Chicago, Ill., has been incorporated with a capital of $10,000, to operate a metal-plating plant. The principal incorporator is Lee J. Howard.

Capital Increases, Etc.

THE AMERICAN OIL & SUPPLY CO., 238 Wilson Ave., Newark, N. J., has filed notice of increase in capital from $100,000 to $500,000.

THE HENDERSON TIRE & RUBBER CO., Buffalo, N. Y., has filed notice of increase in capital from $550,000 to $650,000 for proposed expansion.

THE DIAMOND GLUE CO., Robinson St., Chicago, Ill., has filed notice of increase in capital from $500,000 to $2,000,000 for general expansion.

THE DAMON OIL CO., Tulsa, Okla., has filed notice of increase in capital from $50,000 to $1,000,000 for proposed expansion.

THE CAMDEN POTTERY CO., Camden, N. J., manufacturer of sanitary earthenware products, has arranged for an increase in capital from $200,000 to $500,000.

THE EASTERN TANNERS' GLUE CO., River St., Gowanda, N. Y., has arranged for an increase in capital from $1,500,000 to $2,500,000 for general expansion.

THE DUNLOP TIRE & RUBBER CORP. OF AMERICA, River Road, Buffalo, N. Y., has disposed of a bond issue of $15,866,700, a portion of the proceeds to be used for expansion.

THE OAKLAND CHEMICAL CO., 59 4th Ave., New York, N. Y., has filed notice of increase in capital from $10,000 to $750,000 for general expansion.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting in Pittsburgh, Pa., Feb. 11 to 17, 1923.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting April 3 to 7, 1923, at New Haven, Conn.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting May 3, 4 and 5, 1923, at the Commodore Hotel, New York City.

AMERICAN ENGINEERING COUNCIL, executive organ of the Federated American Engineering Societies, will meet in Washington, D. C., Jan. 11 and 12, 1923.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its annual meeting in New York City during the week of Feb. 19, 1923.

AMERICAN SOCIETY FOR STEEL TREATING will hold its winter sectional meeting in the City Club, Chicago, Feb. 8 and 9, 1923.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-sixth annual meeting at the Chalfonte-Haddon Hall Hotel, Atlantic City, beginning Monday, June 25, 1923, and ending either Friday or Saturday of that week.

INTERNATIONAL CHAMBER OF COMMERCE will hold its second general meeting in Rome, Italy, March 19-26, 1923.

NATIONAL FOREIGN TRADE COUNCIL will hold its annual conference April 25, 26 and 27, 1923, in New Orleans, La.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS, with headquarters in Chicago, will hold its spring convention in Cincinnati, April 18, 19 and 20, 1923. The major subject will be "Management Problems of the Smaller Plants."

A PAPER INDUSTRIES EXPOSITION will be held in Grand Central Palace, New York City, during the week of April 9, 1923, by the International Exposition Co.

The following meetings are scheduled to be held in Rumford Hall, Chemists' Club, East 41st St., New York City; Jan. 12—Society of Chemical Industry, Perkin Medal. Feb. 9—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting. March 9—American Chemical Society, Nichols Medal. March 23—Society of Chemical Industry, regular meeting. April 20—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting. May 4—American Chemical Society, regular meeting. May 11—Société de Chimie Industrielle (in charge), American Chemical Society, American Electrochemical Society, Society of Chemical Industry, joint meeting. May 18—Society of Chemical Industry, regular meeting. June 8—American Chemical Society, regular meeting.